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IN CONJUNCTION WITH

DR. E. GRUENING, OF NEW YORK, AND DR. CL. J. BLAKE, OF BOSTON.

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OPHTHALMOLOGICAL PART.

LARGE ORBITAL SARCOMA, REMOVED WITH PRESERVATION OF THE EYEBALL. DEATH FROM ACUTE NEPHRITIS. AUTOPSY.

By H. KNAPP.

(With two wood engravings.)

On the 27th of October, 1875, John B., aged 38 years, presented himself at the New York Ophthalmic and Aural Institute, seeking relief from a high degree of exophthalmus on his right side. He was a tall man, who for years had suffered from inveterate syphilis. His complexion was sallow; his forehead marked with small, irregular scars; upon his upper lip were numerous red hemispherical nodules; on the right side of his head was a round depression of about $1\frac{1}{2}''$ in diameter; the region of the apex of his left lung was dull on percussion; his digestion was poor; he was subject to diarrhœa, and had felt weak for a long time. The syphilitic infection, he stated, had taken place about ten years ago, and he had never since felt a healthy man.

His right eye protruded forward, downward, and outward, to such a degree that he could hardly close the lids over it. The exophthalmus had first been noticed two years previously, and had slowly but steadily increased, more rapidly of late. The globe moved in every direction, but less extensively than its fellow. The restriction of its mobility was greatest toward the nose. The appearance, sensibility, and tension of the eye were normal. *The vision was totally abolished.* The media were clear; the fundus exhibited the ordinary picture of neuritis descendens. On palpation, by which the globe was readily displaced before the eyelids, a painless, hardish, incompressible, uneven, immovable tumor was felt in the inner and lower part of the orbit. It remained stationary during the most extensive movements of which the eyeball was capable. A small interspace was felt between the tumor and the globe, but none between the tumor and the orbital walls.

From these symptoms I inferred that the exophthalmus was caused by a growth which was in connection with the inner and

lower walls of the orbit. No cerebral disturbance being present, the nasal passages being freely pervious, and the size and shape of the upper maxilla, especially the region between the molar teeth and the skin of the cheek, showing no abnormity, I assumed that the growth was limited to the orbit. Its extension into the maxillary antrum, in particular, could be excluded, since in this case the eyeball would have been dislocated upward, instead of downward and outward.

As to the *nature* of the tumor, I presumed that it was *fibro-sarcomatous.*

Fatty and fibrous tumors, which frequently develop in the cellular tissue of the orbit, are not likely to be so extensively and firmly connected with the orbital walls as in the case under consideration.

Carcinomata in the orbital cavity seldom fail to cause intense pain, and as, in this case, pain was altogether absent, I did not think that I had to deal with a carcinoma; besides, the patient had not yet attained that period of life, *i. e.*, forty-five years, after which we usually meet with cancers.

A *tumor of the optic nerve* could likewise be excluded, since such tumors push the eyeball straight forward, move together with the globe, and leave no space, perceptible by palpation, between themselves and the globe, but leave a free space between themselves and the walls of the orbit.

The possibility of a *chondroma* could not be excluded, but the formation of cartilage seems so rare in the orbit that, without special indications, we can hardly venture to diagnosticate it.

A *gumma* might well be thought of, considering the pronounced syphilitic taint of the patient; but gummata in the orbit, as far as I know, have never been described, and hardly anywhere attain such a size as the growth under consideration had.

An *osseous growth* could not be assumed, since the tumor, on palpation, felt less hard than bony substance.

Nor could the growth be of a *vascular* nature, on account of its toughness and incompressibility.

The *prognosis* was very unfavorable. The steady and, of late, rapid increase of the protrusion of the globe, over which the lids

were closed with difficulty, would soon have been followed by sloughing of the cornea and panophthalmitis; the pseudoplasm would have pierced the conjunctiva, ulcerated on its free surface, and caused the death of the patient, either by exhaustion or by extension into the neighboring cavities, especially the cranial.

Under these circumstances, the *removal of the pseudoplasm* seemed to be indicated. The freedom of the neighboring cavities made it probable that the growth might be completely removed and life saved. As the bulk of the tumor seemed to be located in the inner part of the orbit, I even thought it possible that the eyeball might be spared, and with these views I *proceeded to the operation* on Oct. 29th, 1875.

When the patient was fully under the influence of ether, I divided, with a pair of strong scissors, the upper lid vertically, about a line laterally from the lachrymal point. Next I cut with a bistouri through the conjunctiva and orbital tissue down to the tumor; then, under the guidance of my left forefinger, I separated the tumor upward and outward from the loose connective tissue of the orbit. The eyeball did not obstruct my way, but I soon found that the tumor surrounded the optic nerve, was in connection with the periosteum of the whole lower and inner sides of the orbit, reached to the very apex of the orbital pyramid, and almost touched its outer wall, leaving only the space near the upper outer corner free. I detached the tumor from its connection with the eyeball, by dividing the inner rectus muscle and the optic nerve; separated it from the inner and lower orbital walls, and severed it as near the optic foramen as my finger and the scissors could reach. This done, the bulk of the tumor was brought out; but a considerable portion had been left in the inner lower corner and in the apex of the orbit. This portion was gradually removed by the scissors, the knife, and a curved gouge, the latter being used as a raspatorium to clean the bone from the soft parts. In this procedure a part of the floor of the orbit was removed, and thus the maxillary sinus opened. On digital examination it seemed that the pseudoplasm had been cleanly removed from the orbit, yet some suspicion was left as to its extension into the inferior orbital fissure. To remove the soft parts which filled this fissure appeared impracticable. The eyeball was forcibly pushed back into its socket, the incision in the upper lid was closed with two sutures, and a charpie-flannel bandage applied.

The operation had lasted over an hour, during which the patient often

awoke from his narcosis and drank some claret. He appeared very weak, though he lost but little blood. I will mention that before the bandage was applied, the tension and sensibility of the eyeball were tested by myself and several surgeons who had kindly assisted me during the operation, namely: Drs. H. B. Sands, C. S. Bull, T. R. Pooley, E. Gruening, and others. The tension of the globe did not appear diminished, the sensibility was abolished in the whole inner half of the eyeball, but preserved in the outer. The pupil was immovable and somewhat more than middle wide. The fundus oculi was pale red, the larger retinal veins were filled, the arteries and smaller vessels of the retina not recognizable.

Course of disease after the operation.

The patient passed a good night. The wound discharged yellowish pus. Pulse 104. He had diarrhœa. On the supposition that syphilis might be the cause of the diarrhœa, a scruple of iodide of potassium was given three times daily, but without any effect. His diarrhœa increased during the following night (6 or 7 stools), and he vomited several times. His pulse was very feeble, the radial artery felt hard, cord-like; sour eructations. Ordered: Bicarbonate of soda. There was a slight grayish infiltration on the lower margin, and a superficial ulcer in the outer half of the cornea. The inner half was clear, and afforded a tolerably good view of the fundus, which appeared grayish red, the optic disk and retinal veins being recognizable. Tn. Sensibility in inner half of globe abolished, in outer preserved as the day before. The eyelids were closed by a suture.

On the *third* day after the operation the patient felt weaker than before; he vomited all the food he took, and his diarrhœa continued. Ordered: Claret; creosote gtt. iii. in mucilago salep ʒji. Pulse 124.

On the *fourth* day, a slight improvement. Less vomiting and diarrhœa. Wound discharged thick, creamy, offensive pus, and was cleansed by syringing with lukewarm water. The sutures in the lids were removed. The ulcer of the cornea was the same as before. The optic disk was pale, the fundus reddish, several retinal vessels visible. Tn.

On the *fifth* day, vomiting and diarrhœa again. No pain on pressure upon the abdomen; dull percussion sound of spleen, extending beyond the natural limits. Tongue red and dry. Ordered: Subnitrate of bismuth, and black coffee. Neither allayed the vomiting.

On the *sixth* day, diarrhœa and vomiting persisting, delirious at times, no headache, pulse 136, great general weakness. Infiltration of cornea increased, wound discharged freely. Ordered: Bicarbonate of soda, with opium. Patient took no food, and toward evening had a moderate degree of trismus.

On the *seventh* day there was in all the symptoms a marked improvement, which continued until the *tenth* day, when, although free from vomiting and diarrhœa, he lost all his appetite and collapsed conspicuously. Taking some brandy was followed by vomiting. He could not pass his urin. The amount of urin taken by the catheter was scant, and contained albumen. The lower half of the cornea sloughing and perforated. Discharge of wound purulent, copious, and offensive.

Eleventh day after operation: Prostration, deliria, hands and feet numb, trismus, diarrhœa, and vomiting again, pulse 90, scarcely to be felt.

On the *twelfth* day, coma, occasional convulsions of upper extremities, and, at 5.30 A.M., death.

The *post-mortem* examination was made on the afternoon of the same day by Dr. *C. Heitzmann*, in the presence of Drs. Pooley, Gruening, Gebser, Alt (the resident surgeon of the Institute), and myself. Leaving out irrelevant details, I will mention the following conditions:

The *cranial bones* were thickened and compact. On the outer surface of the right parietal bone, near the sagittal suture, was a roundish uneven depression in the bone of $1\frac{1}{2}''$ in diameter (evidently the result of a tophus). Dura mater pale. Pia moderately congested. Emphysema in upper lobes of both lungs. In the *apex* of the *left lung* a tough, grayish infiltration, the size of a child's fist. In the other parts of the lungs abundant serum; in the bronchi a good deal of muco-pus.

The *intestinal tube* presented nothing remarkable, its mucous membrane was pale, without ulcers or infiltrations.

The *spleen* was three times its natural size, tough, its capsule thickened, the substance deeply red-brown, friable, interspersed with numerous spawn-like granules (amyloid).

The *liver* was large, congested, with many small, shallow cicatricial depressions. Its section surface was nutmeg-like. A hardish, uneven, whitish-yellow tumor, the size of a large walnut, was situated on the anterior edge of the liver, near the ligamentum teres.

Both kidneys had double the natural volume. Their surface was marked with a multitude of small stellate anastomoses of congested blood-vessels. The cortical substance was two to

three times its natural thickness; was grayish-yellow, and on pressure yielded a yellow juice. The pyramids were enlarged, their red substance was lardaceous, and pervaded by pencils of straight yellow lines. The mucous membrane of the calices was congested.

The *left testicle* was very tough, and double its natural size. Its parenchyma was replaced by a tumor the size of a walnut, containing a cheesy substance with some small cavities, and was surrounded by a tough, fibrous tissue.

The *eyeball* was collapsed; the cornea had sloughed; the nasal side of the sclerotic was shining white. By pressure on the lids and the eyeball, a small quantity of thick pus escaped through the wound.

The *chiasm* and the *optic nerves* were normal, nor was there any change at the cranial side of the optic foramen and superior orbital fissure.

After the eyeball had been freed from its conjunctional attachments, the bones of the whole roof and lateral walls of the orbit were severed with a chisel and hammer and removed, together with the contents of the orbit, including the eyeball. The bone at the floor of the orbit was defective. Highmore's antrum and the inferior orbital fissure were filled with pus, and the pseudoplasm extended into the inferior orbital fissure.

POST-MORTEM DIAGNOSIS: *Nephritis acuta crouposa. Pneumonia tuberculosa chronica apicis pulmonis sinistri. Degeneratio amyloidea lienis. Gumma fibrosum hepatis et testiculi sinistri.*

CAUSA MORTIS: *Uræmia e nephritide acuta post exstirpationem tumoris orbitæ dextræ.*

THE MICROSCOPIC EXAMINATION of the orbital tumor discovered the characteristic features of *sarcoma.* The cellular elements, prevalently round or oval, were largely in excess of the scant homogeneous or finely-striated matrix. In some places the elements were small and more or less uniform, resembling the glioma type; in others they were spindle-shaped; and here and there giant cells (myelopaxes) were present. The pseudoplasm had no definite boundary, but scattered its elements more or less densely through the adjacent parts. The fibres of the cellular tissue of the orbit were crowded asunder by the inva-

sion of the sarcoma cells, in such a way that in these places the growth had the appearance of a fibro-sarcoma. Parts of the recti muscles to the naked eye were barely recognizable as parallel cords running through the dense and uniform substance of the tumor. Under the microscope they exhibited a typical picture of the conversion of muscle into sarcoma.

The perimysium internum was tolerably well preserved, and formed a sharply-defined, somewhat coarse and irregular framework, which enclosed the broken-up bundles of the muscles and the elements of the new growth. The substance of the muscle was well recognizable by its distinct transverse striation, and its greenish-yellow color. Taking this coloration as evidence, we could infer that the muscular substance, in its decay, served to build up the elements of the new growth, since many cellular formations—nuclei and protoplasm—were distinctly yellow, and these were such cells as lay around the broken-up muscle bundles,

FIG. 1.

the characteristic striation of which was well preserved (see the accompanying Fig. 1), whereas in all other parts the elements of the new growth were colorless.

The *optic nerve* passed straight through the tumor, and appeared

somewhat thickened. Transverse sections, examined with low magnifying powers, showed no conspicuous change in the appearance and arrangement of the bundles of nervous fibres, nor in the connective tissue surrounding them (perineurium internum), the inner and outer sheaths of the nerve, and the subvaginal space. Higher magnifying powers, however, discovered in the middle portion of the nerve a total destruction of the nervous fibres, their place being taken by an irregular, delicate, fibrous lace-work, densely interspersed with smaller and larger round and oval cells. Many of the cells had the size and appearance of white blood corpuscles; others were larger, had distinct outlines, cell-substance, and nuclei, with shining nucleoli. Among the cells circumscribed accumulations of protoplasm were conspicuous by their translucency and whitish coloration, different, however, from colloid formations. Throughout the whole nerve, except that part which was nearest to the optic foramen, the perineurium internum was unchanged, whereas the inner sheath exhibited the most advanced degree of colloid degeneration.

The invasion of sarcoma cells into the bundles of the optic nerve fibres could be followed throughout the whole length of the nerve, even to its intra-ocular end and the adjacent retina. In the vicinity of the sclerotic a considerable amount of nervous fibres was still preserved, and the cells of the neoplasm lay crowded between them. The physiological attenuation of the nerve in the scleral canal was unchanged. *The intra-ocular end of the nerve was swollen exactly as we find it in ordinary cases of optic neuritis* (see the accompanying Fig. 2). Immediately upon the cribriform membrane the accumulation of sarcoma cells was so abundant that it crowded out almost every other tissue element. The nervous fibres could not be traced beyond the lamina cribrosa into the eye. The sarcoma cells extended laterally into the middle layers of the retina. The outer granular layer was somewhat removed from the choroidal aperture, but had preserved its integrity, and was well distinguished from the sarcoma elements resting upon it. This condition was present as far as the swelling of the entrance of the optic nerve and its vicinity reached, that is, about two-thirds of the diameter of the normal disk beyond the margin of the choroidal aperture. In the super-

ficial and peripheric layers of the swollen end of the nerve, the

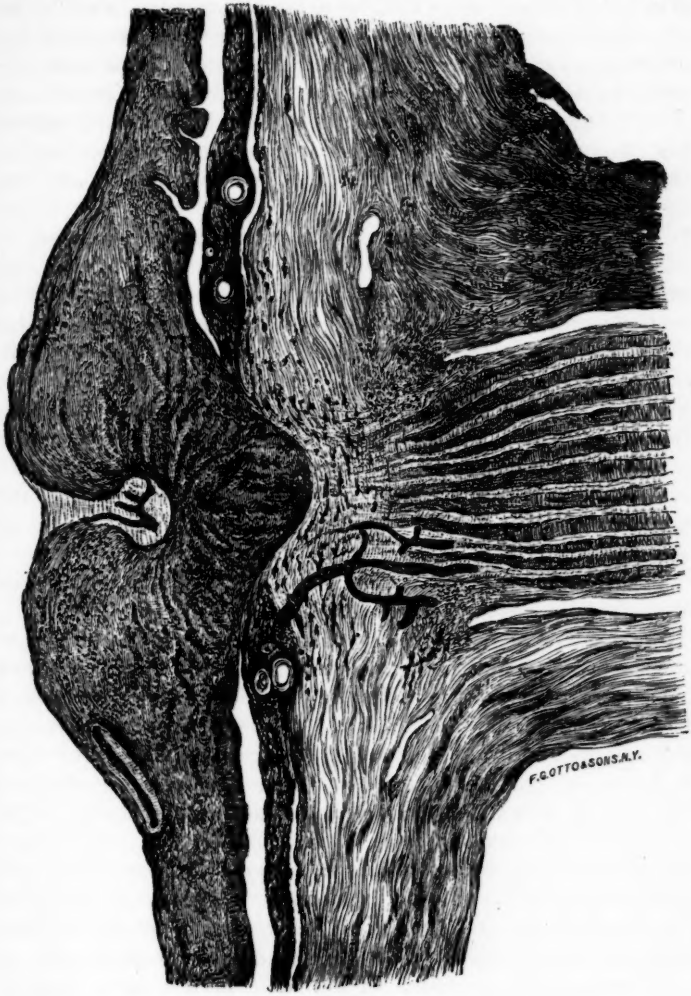

FIG. 2.

elements of the pseudoplasm were commingled with the usual

products of inflammation; delicate fibres, partly parallel, partly irregularly interwoven, enclosing a large number of small round or oval corpuscles lying isolated or in clusters between the fibres. There was a marked depression in the centre of the papilla. Besides the empty central blood-vessels, other well-filled vessels were seen. The preparation, which is copied in the preceding engraving, shows the communication between a ciliary blood-vessel in the sclerotic and the vessels in the optic nerve and the adjacent choroid.

The intervaginal space was free from any foreign substance.

Near the optic foramen the nerve was compressed by the orbital growth, its outer sheath was thickened and disorganized by the invasion of the cells of the pseudoplasm, which crowded the fibres asunder, forming between them multiple rows and irregular clusters of various sizes. The sheath touched the nerve without any intermediate substance, and in some places the continuous transition of the elements of the pseudoplasm from the sheath into the nerve could be demonstrated. The sarcoma cells, at this place, were situated in the perineurium as well as in the nervous fibre-bundles. The chiasm and optic trunks showed no abnormity.

The inner organs were examined by Dr. *C. Heitzmann*, who kindly gave me the following description:

Liver.—The node on the anterior margin of the liver consisted of finely striated connective tissue, the bundles of which crossed one another in different directions. On longitudinal sections, the bundles appeared well provided with spindle-shaped protoplasmic bodies, the oblong and round nuclei of which were well preserved. The majority of these bodies had undergone fatty degeneration in such a way that the bundles could be recognized only by the rows of fat-globules. In some places there were large accumulations of fat-globules, partly between, partly within the bundles of connective tissue; and in the latter case, the abundant fatty infiltration had destroyed the striated structure of the bundles. The tissue had but few blood-vessels.

Testicle.—The structure of the node in the right testicle was the same as that of the node in the liver. Here, also, a large amount of the tissue was destroyed by fatty degeneration.

Kidneys.—Sections taken from the cortical layer showed intense filling of the blood-vessels with blood corpuscles. The connective tissue between the tubuli was hypertrophied, and pervaded by nuclear formations. Numerous uriniferous tubuli were enlarged and filled with a hyaline, faintly-shining substance (fibrinous casts). The epithelium of such tubuli was mostly detached, or reduced to flat formations, which appeared spindle-shaped when transversely cut. In some tubuli, especially the contorted, the epithelium appeared considerably enlarged, so as almost to obstruct the calibre of the tubuli. The enlarged epithelial cells, a part of which had coalesced into considerable conglomerations, were abundantly filled with coarse granules (opaque swelling), or infiltrated with fat globules. The interstitial tissue, likewise, in some places was saturated with fat granules. Besides these granules, numerous crystals of margarinic acid were noticed.

Spleen.—The spleen contained numerous brightly-shining amyloid bodies and tube-like formations of the same nature, evidently the result of amyloid degeneration of the arteries.

REMARKS.

The *clinical diagnosis was confirmed by the autopsy.* The slowly growing exophthalmus was caused by a periosteal sarcoma of the orbit. The growth filled the greater part of the orbit, involved and disorganized the inner rectus muscle, surrounded the optic nerve, invaded the outer sheath at one place only, and there penetrated into the nerve itself. This place was the point of contact between the periorbita and the sheath of the nerve at the optic foramen. It is easily explainable why just this place served as the bridge for the passage of the growth into the nerve, since we have to regard the periosteum as the starting-point of the growth. In the anterior part of the orbit there was free space enough for the pseudoplasm to expand, without encroaching upon the sheath of the optic nerve, which is, by its dense fibrous structure, very resistant, and unfavorable to the development of inflammatory processes. The apex of the orbital pyramid, on the other hand, was completely filled by the growth,

and the nerve even compressed by it. In its extension, the pseudoplasm had the choice between the bony wall of the orbit and the sheath of the optic nerve. The sheath of the nerve, we may fairly suppose, offered less resistance than the orbital wall.

Having entered the optic nerve in some place, the elements of the sarcoma spread in the nerve. The *mode of their propagation* is very remarkable. The current of the proliferating elements was directed exclusively toward the periphery, *i. e.*, toward the eyeball; for we saw the intracranial end of the nerve, *i. e.*, its emergence out of the chiasm—further, of course, the chiasm itself and the optic trunks—intact; whereas, sarcoma tissue was met with in the whole orbital part of the optic nerve, and even in its intra-ocular end. This remarkable condition may be explained as follows: It is well known that pseudoplasms frequently owe their origin to irritative processes. We may therefore conclude that also the extension of pseudoplasms takes place first and by preference in that part of an invaded organ which is the seat of irritative processes. In the case under consideration irritative processes were present in the orbital part of the optic nerve, but absent in its cranial part. It is natural to suppose that the tumor caused inflammatory irritation of the optic nerve by pressure and stretching, if not by its specific qualities. In a case of carcinoma of the sheath of the optic nerve, recorded in these Archives (Vol. IV. page 335), I have described and illustrated (Tab. xi. Fig. 11) the occurrence of genuine inflammation of the optic nerve. Supposing the resistances to be equal in the orbital and cranial parts of the optic nerve, the inflammatory irritation in the orbital portion of the nerve must have decided the centrifugal propagation of the sarcoma.

Another remarkable condition was the *presence of the sarcoma elements in the bundles of the nervous fibres, and their absence in the interstitial connective tissue.* This fact seems surprising, since we know that pseudoplasms almost invariably take their origin in the connective tissue. Based on this doctrine, I have also placed the origin of the tumor under consideration in a connective tissue membrane—the periorbita; but the fact that the proliferating elements of the pseudoplasm, within the optic nerve, were situated in the nervous bundles, and not in the interstitial tissue, I

can only account for by supposing that the nervous fibre, by its easy decomposition and its abundance of protoplasm, is more easily converted into the tissue of the proliferating pseudoplasm than the perineurium, which has but little protoplasm.

Though this explanation appears plausible enough, I will not omit in its support to recall the building up of the sarcoma by muscular substance, as described above, and illustrated by Fig. 1. In that place, the sarcoma elements which lay in the vicinity of decaying pieces of muscle were distinguished by the greenish-yellow color, which is peculiar to the muscular substance. This is, I suppose, evidence enough to believe that the protoplasm of the sarcoma cells was derived from the muscular substance. Further, I may mention that retinal glioma also has been seen to propagate within the fibre-bundles of the optic nerve, and to completely replace the fibres, while the interstitial connective tissue remained free. This condition has been very positively described and illustrated in these Archives, Vol. II., page 172, etc., Plate 5, Fig. 5, by F. DELAFIELD.

Another very remarkable condition, in the case under consideration, was the presence, in the intra-ocular end of the optic nerve and its nearest vicinity, of numerous accumulations of sarcoma cells, conspicuously distinguished from the surrounding tissue. Even low magnifying powers (see Drawing No. 2) sufficed to demonstrate that the foreign elements had reached this locality by direct transition from the optic nerve through the cribriform membrane. By weak magnifying power we noticed, upon the cribriform membrane, conspicuous dark roundish clusters and cords, which by high powers manifested themselves as being identical with the elements of the extra-ocular growth. These clusters did not reach the surface of the retina, but were covered by the inner retinal layers, which were swollen by being saturated with an abundant amount of inflammatory products. Had the growth been permitted to run its course unchecked, it would doubtless have freely expanded into the interior of the globe. This condition is nosologically of importance, since it presents an unusual way by which the pseudoplasm extended from the orbit into the globe. *The optic nerve is the usual passage by which pseudoplasms travel from the interior*

of the eye into the orbital and cranial cavities. In the case under consideration the passage remained the same, but the direction of propagation was the inverse. During life the ophthalmoscope discovered on the swollen optic disk no peculiar features distinctive from the ordinary picture of neuritis descendens, and no suspicion could be raised that the elements of the pseudoplasm might have penetrated the globe. From some instances of my own experience I am forced to conclude that orbital growths cause the picture of neuritis descendens only when they encroach upon the sheath of the optic nerve, and occasion inflammation in the nerve itself. This, at least, was the condition in the above-mentioned case of carcinoma of the outer sheath, in which a marked choked disk was present, together with moderate acuity of vision and a complete visual field. On the other hand, I have seen cases of peripheral orbital tumors which produced very considerable exophthalmus and great swelling of the conjunctiva and eyelids, whereas the sight was almost completely preserved, and ophthalmoscopically nothing but venous hyperæmia and slight cloudiness (œdema) of the retina were seen. A mere contraction of space in the orbit, with subsequent pressure upon the orbital vessels, does not, therefore, suffice to cause the occurrence of neuritis descendens. Such observations are conclusive evidence that GRAEFE'S explanation of the stauungs-papilla (choked disk) is untenable.

Whereas, in the above-quoted case of extirpation of the optic nerve with preservation of the eyeball, no retinal blood-vessels were visible for three or four days, and the whole background of the eye appeared milky, *in the case under consideration the retinal vessels never disappeared entirely, and the background of the eye was reddish-white instead of purely white.* Immediately after the operation, and some days later, the main venous branches of the retina were seen with the ophthalmoscope, and every day a greater number of retinal blood-vessels were filled with blood, and the fundus appeared reddish. The same condition was still more pronounced, in the case of a patient at the Ophthalmic and Aural Institute, in which Dr. *Gruening* successfully removed a myxoma of the optic nerve with preservation of the eyeball. The reason of this condition is

easily understood from the arrangement of the blood-vessels, as is presented in Fig. 2, page 139. The trunk of a ciliary artery gives off branches into the head of the optic nerve, and these communicate directly with the choroidal vessels by a broad anastomosis. Although the ciliary artery was severed behind the sclerotic, the head of the optic nerve and the retina were supplied with blood by communications from the choroid, of which I have spoken at length in the former case. The more numerous these communications are, the less the section of the optic nerve will interrupt the retinal circulation and disturb the nutrition of the tissue. In this case, we of course presuppose that all the ciliary arteries which form the vascular circle around the optic nerve were severed.

Was, in the case under consideration, the operation indicated? Though the occurrence of the acute nephritis, even if we consider it as being induced by the suppurating wound, occasioned the death of an individual so exhausted, the performance of the operation may be justified. For, even if we had known all the conditions which only the autopsy revealed, it would have been impossible to determine beforehand that the patient was unable to sustain the operation. This uncertainty on the one side, and the certainty of a fatal and very painful termination on the other, seem sufficient to justify the performance of the operation.

Was the operative procedure the most appropriate that could have been chosen?

One objection only could be raised against it, viz.: That the preservation of the blind eyeball was useless, and made the operation unnecessarily difficult. No doubt the operation would have been less difficult, had the globe first been removed. But the operation was possible with preservation of the eyeball, and I doubt whether the extirpation of the growth could have been more radical if the globe had been previously enucleated, since the access to the whole orbital cavity on the side of the dislocated eyeball was amply large enough. Based upon the experience gained in this very case, I shall, still more than I did before, endeavor to preserve the eyeball in the removal of orbital growths. If, during the operation, it should become evident that the globe renders the radical operation of an orbital growth

impossible, or at least uncertain, the globe may be removed at any moment. But if we succeed in removing an orbital tumor with preservation of the eyeball, we render the patient a material service, and even though the eye be blind, it would, for many reasons, be preferable to an artificial eye. Not long ago I saw the patient again from whom I removed, as was repeatedly mentioned, the carcinomatous growth of the sheath of the optic nerve. The operation was performed two years ago. The eyeball has preserved its natural shape, and the patient has not suffered since. Whether she will long remain free from suffering is doubtful, considering the malignant nature of the tumor removed. Completely successful and free from any misgivings is the case, here likewise cited, of a myxoma of the optic nerve which Dr. E. GRUENING removed, with preservation of the eyeball, about six months since. On the strength of these observations I consider the preservation of the eyeball, in such cases of orbital growths in which the eyeball was formerly removed, a triumph of operative surgery. This will apply chiefly to benign growths, for since the almost unavoidable relapses of malignant tumors involve the eyeball soon afterward, the preservation of the eye, in such instances, is of little value, especially when the other eye is healthy. This sentence is indeed a severe criticism of the case under consideration, as the orbital growth was not only malignant, but could not even be radically removed. *The operation here came too late.* If it had been undertaken while the tumor was limited to a part of the orbital wall, it would have probably been possible and perhaps easy to remove it radically and preserve the eye. If we further admit that the tumor must not of necessity have originated in the apex of the orbital pyramid, the exophthalmus might have served to suspect and diagnosticate its presence before the optic nerve was implicated. The growth might then have been removed with preservation of a useful eye.

I cannot close these remarks without saying a word on the so-called *neuro-paralytic ophthalmia.* Immediately after the operations the inner half of the globe, as could be expected, was found totally insensible, while the outer was sensitive. This condition persisted through the whole course of the disease. To our surprise we noticed, soon after the operation, on the

outer, sensible part of the cornea, an ulcer which gradually enlarged, deepened, extended over the lower half of the cornea, and led to perforation. The inner insensible part of the cornea remained clear, and rendered the opthalmoscopic examination of the fundus possible. Had the inner part of the cornea been affected instead of the outer, the case might have been considered by some as an example of neuro-paralytic ophthalmia, and adduced in support of the trophoneuristic theory.

RIGHT-SIDED BINOCULAR HEMIOPIA, DEPENDING UPON A GUMMY TUMOR IN THE LEFT POSTERIOR LOBE OF THE BRAIN.

By Dr. T. R. POOLEY, of New York.

A gentleman 55 years of age consulted me, September 14, 1875. Thirty years ago he had a chancre which was only followed by a slight pharyngitis. He took mercury and iodide of potassium for a time, and has had no manifestations of the disease since. He was married, and had two healthy children, the eldest being about 20 years old. Six weeks before his first visit to me he complained of mental illusions and epileptiform convulsions, severe and prolonged, followed by maniacal excitement, lasting several hours, since which he has had slight frontal headaches. After the last attack he had disturbance of vision, "fluttering" before his eyes, but no diplopia. When he came to me he felt dizzy, talked confusedly, omitted words, was exceedingly emotional. He had slight periodical headaches, with nightly exacerbations, and a great desire for sexual intercourse. There was M. $\frac{1}{10}$, S. $\frac{8}{20}$, slight insufficiency of the interni, and small staphyloma posticum of both eyes.

Dr. Keyes and I made the diagnosis of cerebral syphilis, and ordered iodide of potassium, bromide of potassium, and bromide of ammonium. His field of vision was intact, but, two days later, he returned, saying that he could not see objects which were on his right side. On examination, I found that he had *right-sided hemiopia of both eyes, sharply defined in the vertical meridian.* He took the prescribed remedies for a month, during which time he improved in all particulars, and even lost his hemiopia for a time. It soon reappeared, however, and continued uninterruptedly afterward until his death. About the beginning of November, I first observed that he had partial hemiplegia of the right side, and some paresis of sensation of the right arm. His memory was more impaired, and in conversation he was often at loss for the appropriate words. He continued much in the same condition until about Christmas, when he became very feeble, vomited frequently, and emaciated considerably. He recovered again from this attack. The hemiplegia and aphasia, however,

were more pronounced. Early in March his condition became worse again, and attacks of vertigo amounting almost to loss of consciousness, became more frequent. On the 30th of March he complained of diminution of vision of his left eye. I found S. $\frac{20}{30}$, and choked disk in the left eye, whereas there was no change in the right. I now confidently persisted in my previously expressed diagnosis of intracranial tumor, and gave a hopeless prognosis, thereby preventing a journey to the Hot Springs in Arkansas.

In the night of April 7th he had very intense pain in the head, followed by tonic convulsions and coma, in which condition he died early in the morning of the 8th of April.

The autopsy of the cadaver, which was well preserved on ice, was made thirty hours after death, in the presence of Drs. *Bowden*, *Lynch*, and *Jordan*, by Dr. *Knapp* and *myself*. On the inner surface of the calvarium were two small defects of substance, apparently caused by an absorption of the inner table.

Meninges normal. The dura, however, in the posterior portion of the posterior lobe was adherent to the bone and thickened, the surface of adhesion being about the size of a cent. Right hemisphere normal. The left posterior lobe was somewhat enlarged, and had a depression in its posterior portion, in which, embedded in the substance of the brain, lay a yellowish-white, rather hard, and roundish tumor, of about $1\frac{1}{4}''$ in diameter, and $\frac{1}{2}''$ thick. It was closely adherent to the dura and pia, from which it had to be detached with the knife in removing the brain. There was a considerable extent of softening of the brain substance, which in the immediate vicinity of the tumor was almost liquid, and quite gradually increased in consistency as it passed over into the normal brain substance. The softening extended from the posterior through the entire middle lobe, and ceased at the anterior portion of the anterior lobe, and at the posterior margin of the posterior lobe. The left thalamus opticus and the neighboring brain substance were completely softened.

The cerebellum was normal.

The chiasma and trunci optici showed no abnormality throughout their entire course. The right lateral ventricle was greatly dilated, and filled with serum. In the apices of both lungs

chronic pneumonia and pleuritic adhesions. Heart normal. Liver irregularly lobulated, with three large stellate scars upon its anterior border. Spleen normal. Kidneys, with the exception of some hyperæmia of the cortex, normal. Nothing remarkable was found in the remaining parts of the body.

The tumor had a solid, somewhat whitish, centre, and a rather less consistent hyaline periphery. It had all the characteristics of a gumma.

It is my intention to examine the preparations more carefully, and to report the result in another communication.

The present observation, however, is of special interest, because it clearly demonstrates binocular right-sided hemiopia, depending upon a just as clearly demonstrated lesion of the left thalamus opticus and the adjacent parts of the brain. The right hemisphere was normal.

The foregoing case is, therefore, a further, and, it seems to me, indubitable proof of the occurrence of a semidecussation of the optic nerves in the chiasma.

A CASE OF FILARIA MEDINENSIS IN THE ANTERIOR CHAMBER.

By Dr. A. BARKAN, of San Francisco.

Daniel S———g, a native of Adelaide, Australia, 30 years old, unmarried, consulted me, shortly after his arrival in California, respecting his defective eyesight. It appears that about ten years ago the patient received, in a hostile encounter with one of the Aborigines, injuries to his eyes, which left them in a swollen, discolored, and painful condition; the eyelids, after this trauma, remained continually sore, painful, and were glued together in the morning. Photophobia and lachrymation set in, the cornea became implicated, and, under severe caustic treatment, the patient's vision grew steadily worse, until he was admitted, almost blind, to the hospital at Adelaide; there he remained under treatment two years. When he left the hospital his eyes were free from inflammation, but very sensitive to light, and greatly defective in sight. Only a few days after his discharge from the hospital, whilst celebrating his recovery with a few friends, a glass filled with brandy was thrown into his face. His eyes became much inflamed and he was forced to return to the hospital, where he remained under treatment for another year, when he was again discharged. The patient's eyes remained weak for some years, and, owing to their impaired vision, were of little use.

"Having," so the patient said, "gone through the hands of twenty-three oculists and physicians," he presented himself to me in the following condition: The palpebral conjunctiva of either eye presented the characteristic appearance exhibited after long-continued and severe caustic treatment; the cornea of the right eye, nearly in its whole extent, was covered with a superficial, thin, cloudlike opacity. The pupils reacted normally, S. $\frac{15}{100}$ H. $\frac{1}{24}$. The left eye slightly deviated outward; the corneal opacity of this eye was denser, but extended only over a little more than its upper half, just covering the pupil; the lower half of the cornea being left perfectly clear, a good view of that part of the anterior chamber was attainable; a whitish threadlike foreign body was seen adherent to the lower part of the iris. During repeated examinations I could perceive no

motion in it; it apparently remained always in the same position; the pupil reacted promptly to light, but did not change the position of the foreign body, of the existence of which the patient was not aware, and from which he suffered no inconvenience. Patient counted fingers at the distance of five feet, H. $\frac{1}{30}$. Tension normal. I first performed a strabotomy of the left abclucens, and a few days afterward a downward iridectomy, and removed the foreign body, together with that portion of iris to which it was adherent. The patient's vision improved to S. $\frac{15}{70}$.

My suspicion that the foreign body was a filaria medinensis was, on subsequent microscopical examination, corroborated by Prof. Knapp. As only very few cases of filaria within the eye are known, I thought it not superfluous to put a brief history of this case on record.

THE ACCOMPANYING AND CONSECUTIVE DISEASES OF IRITIS.

By Dr. J. SCHNABEL,
Lecturer on Diseases of the Eye in the University of Vienna.

Translated by Dr. Joseph Aub,
Lecturer on Diseases of the Eye, and Ophthalmic Surgeon of the Cincinnati Hospital.

In his article entitled "Ueber die Coremorphosis gegen chronische Iritis und Iridochorioiditis" (Arch. f. Ophth. II., 2, p. 202), v. Graefe laid down two conclusive propositions, which have remained the guiding ones for the pathology of chronic or recurrent iritis and iridochoroiditis. They are as follows: "*The existence of posterior synechiæ, and especially of broad and firm posterior synechiæ, is the principal causative moment of recurrent iritis,*" and "*The closure of the pupil is the starting-point of further complications, and especially of chronic choroiditis.*"

Whilst the second of these propositions has been unanimously accepted as true, latterly some authors have expressed their doubts about the correctness of the first.* My observation of the course of iritis taught me some years ago several facts which led me to attach less weight to the unfavorable influence of the synechiæ, and I gave publicity to my views on this subject at a meeting of the Medical Association of this city.† Since then I have been paying this subject uninterrupted attention, and since the accumulated experiences have developed several things worthy of mention in regard to the second of the above propositions

* See Schweigger, Handbuch der Augenheilkunde, 3 Aufl., p. 328, and v. Arlt. Handb. der ges. Augenheilkde, by Graefe & Saemisch, III., 1, p. 347.

† Wien. Med. Presse, XI., 1, p. 1067.

I have determined to delay no longer with a systematic publication of them.

As regards the cause of recurrent iritis being dependent on posterior synechiæ, I wish, instead of any theoretical explanations, to refer to the following table. I have arranged, according to the predominating cause, 263 cases of iritis, which I have observed in 181 individuals, in the eye department of the General Hospital at Vienna, from the years 1866–1872. All those cases of iritis which were under clinical treatment during this period have been entered, and only those cases have been excluded which were the result of complicated injuries, or which had followed operations, or which played but a subordinate part in a severe disease implicating several portions of the eyeball.

These cases of iritis have been divided into two classes, the acute and chronic. In the latter category are included all those cases in which there existed a progressive iritis, with moderate or totally failing external inflammatory symptoms, or in which, beside positive remains of a previous acute iritis, there existed a progressive amblyopia, whose origin could be brought into direct connection with the iritis.

Of the 180 cases of acute iritis, 165 occurred in eyes which had never before been affected with iritis, nor were they at the same time otherwise diseased;* six occurred in eyes which were then suffering with prolonged inflammations (conjunctivitis 3, keratitis 2, scleritis 1), and nine in eyes which had formerly been attacked with iritis.†

These nine cases of relapsing iritis occurred in six individuals, as follows:

1. F——, Franz, aged 43, was admitted to the hospital in the spring of

* Seventy-nine times there was positive, eight times there was probable evidence that syphilis was the cause of the iritis; five times it was the result of a wound, and three times of a cold. In 70 cases the cause could not be ascertained.

† Of all these 180 cases only six showed the formation of condylomata. In one case I saw a condyloma in an eye with non-specific iritis. Hypopyon occurred only seven times. I only mention this for the purpose of comparing the rare presence of hypopyon in pure iritis, with the remarkable frequency of the same in suppurative keratitis, whether this exists with or without iritis, and thereby demonstrating the incorrectness of the opinion that in keratitis the iris is the source of the hypopyon.

1867, with iritis of the left eye. At the time there were existing several small posterior synechiæ, the result of acute iritis, which the patient had had in the years 1859, 1864, and 1865. Iridectomy was performed on this eye, and since then the patient has been lost sight of.

2. A——, Franziska, aged 69, came under treatment for an acute iritis of the left eye in 1867. Four months previously she had had specific iritis of both eyes, resulting in circular synechiæ of both eyes. At the time of the relapse marked symptoms of syphilis were present.

3. A——, Wenzel, aged 42, was discharged, without any synechiæ, as cured of a rheumatic iritis of the right eye, in November of 1869. Two weeks later he returned with acute iritis of both eyes. This time five adhesions remained. In the course of a year (Nov., 1870) A. was again attacked with an iritis of the right eye, which, therefore, had had three attacks of acute iritis in the lapse of a single year.

4. D——, Anton, aged 25, was discharged from the hospital in March, 1869, cured, without synechiæ, of an iritis of the left eye which had come on without any known cause. In the middle of April, 1869, he returned with iritis of the right eye. During the time the iritis was retrograding in this eye, in the middle of May, he had a recurrence of the trouble in the left eye. This was also cured without leaving any synechiæ. In November, 1870, the patient was again admitted with an iritis. (The records do not show whether the iritis existed in one or both eyes.)

5. S——, Anton, aged 25, was admitted to the hospital in March, 1870, with specific iritis of the right eye, after having passed through a siege of iritis of the same eye in November, 1869. (Whether the first attack left permanent synechiæ or not, is unknown to me.)

6. R——, John, aged 42, was discharged with perfectly free pupils, cured of a specific iritis of both eyes. In August of the same year he had an iritis of the left eye.

I abstain from any discussion of that which is so conclusively proven by these cases, and will content myself with affirming *that it is utterly impossible to give the posterior synechiæ an important position in the ætiology of acute iritis.*

Of the eighty-four cases of chronic iritis which were observed in forty-eight individuals, twenty-two were of a specific nature; in sixty-two of the cases the cause is unknown. All these cases have this in common: the existence of several adhesions between the iris and anterior capsule, or total synechiæ, and progressive amblyopia. Among these are instances in which both eyes were

simultaneously, or almost simultaneously, affected, and progressed with steady diminution of the visual power, without the eyes having ever been injested or painful. It was impossible to observe, in the course of these cases, an apparent delay, a period of retrogression, or signs of a new aggravation. The course of the disease did not differ in the second or third year of its existence, when total posterior synechia, closure of the pupil, bulging of the disorganized iris, formation of cataract, etc., were present, from the course in the first year. There was nothing, therefore, to cause us to suppose that the original causative moment was ceasing to act, and that in place of the first irritating factor, the injurious influence of the adhesions of the iris with the capsule was now predominant. The almost unexceptional occurrence of the disease in both eyes, the simultaneous appearance in both, the similarity of its course, and the peculiar manner in which it manifested its presence, all contradict the opinion that this form of iritis is an aggregate of processes, differing in their cause, but in all other respects similar to the ordinary iritis. The old name of "chronic iritis" is more applicable to the form of disease in question than the one of "recurrent iritis," so much in use now.

For the better comprehension of the classification, it will be necessary to draw a distinction between a chronic inflammation of a steady course, a chronic inflammation with acute exacerbations, and an inflammation distinguished by intermissions and relapses of recurrent iritis. Mention of a relapse, in the true sense of the word, could only be made in the above sketched cases of acute iritis, for only in these was the first inflammation completely cured when the second one made its appearance; only in these was the first attack separated from the second by a period of a totally sound condition of the eye. But since, in these cases also, the second attack of iritis could not be proven to be in direct causative connection with the first, so also for these the name of "recurrent iritis" is as inappropriate as the name of "recurrent conjunctivitis" or "keratitis" would be for a case in which repeated attacks of conjunctivitis or keratitis would exist in the course of two or more consecutive years.

The second group of cases, which I have compiled under the

head of "chronic iritis," contains such diseases which began with an acute iritis, but in which no complete freedom from inflammation ever after existed. On the contrary, the inflammatory symptoms receded sometimes more, sometimes less, and continued often for months in a very moderate degree of intensity, then suddenly to increase; cases which, in short, showed a chronic inflammatory condition, with remissions and exacerbations. For this form of progression, it is true we can doubt the correctness of the positive assertion that the influence of the posterior synechiæ is the principal exciting cause, so long as no clear explanation of the manner in which the synechiæ produce this effect has been given, but we certainly cannot deny the possibility of such an influence.

Among the chronic iritides I have also included such cases in which isolated or circular synechiæ remained, but the subsidence of the acute symptoms was followed by a constant diminution of the visual power, and by intra-ocular changes demonstrated by the ophthalmoscope, without any change having taken place in the iris. Further, such cases in which the loss of vision and the intra-ocular changes followed the iritis, without any changes being seen in the iris, and where the course was suddenly again interrupted by a more or less severe iritis, which ceased after formation of new synechiæ, and disorganization of the iris, or which took a chronic course, thereby resembling, to a great degree, the cases in the first group.

Since, in these cases, I had observed the impairment of vision resulting from choroiditis and the obscuration of the vitreous, prior to the recurrence of the iritis, I came to the conclusion that the choroiditis was simultaneous with the first attack of iritis, and was dependent upon the same cause, and was not, therefore, a result of the iritis itself. The progress of the choroiditis, prior to the iritic relapse, and without any simultaneous change taking place in the iris, I looked upon simply as a further development of the pathological process which had appeared in the choroid simultaneously with that in the iris, but which had not retrograded with it. For how could I suppose that the synechiæ kept up in the iris an irritation which was transmitted to the choroid, while the iris itself, the nearest and most directly affect-

ed part—the bridge over which the inflammation must pass to the choroid—showed no changes whatever, no deviations from the normal condition? As long as the posterior synechiæ are made responsible for the choroiditis, we need not be surprised at the late appearance of the same; on the contrary, we must expect the lapse of a certain period of time after the subsidence of the acute iritis, during which the synechiæ are exercising their baneful influence. Since, however, I could not ascribe this effect to the synechiæ in cases where, in consequence of opacities of the vitreous, choroiditis had been diagnosed months or years after the cure of the first inflammatory attack, and in which the iris had undergone no changes whatever, I was forced to the opinion that the delayed effect of the choroiditis, which had appeared at the same time with the iritis, was due to the fact that it was at first seated exclusively in the anterior portions of the choroid, had progressed very slowly, and only began to affect the visual power when the disease had reached the equatorial region.

In order to test the correctness of my supposition by experience, I undertook to find out what part the deeper portions of the eye played during the existence, or, rather, at the height of the acute iritis. From October, 1874, until the end of July, 1875, I made ophthalmoscopic examinations of all those fresh cases of iritis which were admitted to the general hospital of Vienna for treatment, and compared the obtained results with those I obtained from those cases of chronic iritis which were admitted at the same time, and in which an ophthalmoscopic examination was possible. The number of cases of iritis examined in this manner was only 42. The similarity of the obtained results, however, is so convincing, and the support given them by the history of cases occurring in former years so abundant, that I do not hesitate to assert their general applicability.

Of these 42 cases of iritis, 34 were acute and 8 chronic. The acute attacks occurred in one eye, which had circular synechiæ for the past ten years; in one, which had passed through a siege of specific iritis, eight years ago, without retaining any synechiæ; and in 32 eyes which had never before been affected with iritis. Among the latter were two eyes whose partners had been affected with iritis. Of the acute cases, 23 (in 20 individuals) were of a spe-

cific nature, 1 traumatic, and 10 (in 7 individuals) of unknown origin. In the 8 cases of chronic iritis (in 5 individuals), the cause could not be ascertained.

The ophthalmoscopic examination of individuals suffering with acute iritis revealed, no matter what the cause might have been, most frequently diffuse retinitis; comparatively seldom the presence of changes in the vitreous, and most rarely anomalies in the choroid.

For the sake of comprehensiveness I append a table, which shall contain short remarks on the separate cases.

I. CASES OF SPECIFIC IRITIS.

No.	Name of the Patient.	Age—Years.	Disease.	Remarks.
1	D——, Rosalie....	30	Retinitis o. utr., Iritis o. dextri..	The inflammatory appearances in the iris were very slight and soon retrograded. The pupil was altogether round, of normal size, and normally dilatable. At the time of the admission of the patient, the disease had existed for three weeks. The existence of retinitis in both eyes was discovered when the patient was admitted.
2	B——, Josefa.....	22	Iritis oc. sin., Retinitis o. sin....	The same remarks as in the preceding case apply to this one as regards the intensity, the course, the duration of the iritis prior to the admission of the patient, and also as regards the time when the diagnosis of retinitis was made.
3	R——, Barbara....	29	Iritis oc. sin., Retinitis o. sin....	Iritis slight, thoroughly cured. The retinitis was diagnosed simultaneously with the iritis.
4	P——, Alexander..	37	Iritis o. sin., Retinitis o. sin.....	Three weeks before the admission of this patient, who had both inflammations at the time, he noticed the imperfection of vision. This was followed by the external inflammation.
5	K——, Adolph....	33	Iritis o. dextri.....	No complications.
6	C——, Guiseppe...	50	Iritis o. utr., Retinitis o. utr. Hyalitis o. utr., extensive loss of pigment in the epithelial layer.	The disease had existed in the right eye four months, in the left eye three months, when the patient came to see me. The iritis was treated during this time, however, locally, for the patient had been in the venereal and aural wards of the hospital. The inflammatory symptoms in the iris were very slight; only isolated, thread-like synechiæ were present.
7	P——, Magdalene.	40	Iritis, Retinitis o. sin..... ...	The iritis was seen in the first stage, which was very mild. Retinitis could not be diagnosed on her first admission. After six days' treatment all inflammatory symptoms had disappeared, the pupil

No.	Name of the Patient.	Age—Years.	Disease.	Remarks.
				was regularly dilated. Retinitis existed. During the inunction treatment, and fourteen days after the iritis had entirely disappeared, a new iritis attacked the eye, and was cured in seven days.
8	P——, Caroline...	22	Iritis, Retinitis, Hyalitis o. dext..	At the time of admission the disease of the eyes had existed for two or three months. Numerous filiform synechiæ were present, and the fundus oculi was not clearly discernible. After a short stay in the eye ward, the patient was transferred to the syphilis ward, where the iritis disappeared entirely. The impairment of vision remained, however, so that the patient returned to the eye ward after a lapse of four and a half months, where retinitis and hyalitis were discovered.
9	R——, Barbara....	60	Iritis, Retinitis o. sin.....	Fresh iritis with a few synechiæ, which soon disappeared after the use of atropine. Retinitis observed on admission.
01	R——, Franz.....	65	Iritis, Retinitis o. dextri.....	Fresh iritis, with severe inflammatory symptoms and broad synechiæ. Retinitis was diagnosed at the same time as the iritis.
11	K——, Alois.....	27	Iritis, Retinitis o. sin.....	The iritis commenced fourteen days before admission of the patient, at which time the retinitis was observed. Only one fine synechia existed and soon tore.
12	L——, Marie.....	20	Iritis o. dextri, Retinitis o. utr...	The iritis, of fourteen days' duration at the time of admission, was slight, and soon disappeared entirely. The retinitis of both eyes was diagnosed when the patient came to the hospital.
13	G——, Theresa....	60	Iritis, Retinitis o. dextri.....	Iritis fresh, slight, healing without synechiæ. Retinitis observed on admission.
14	K——, Adalbert...	28	Iritis, Retinitis, Hyalitis o. sin. In the anterior portions of the fundus, the epithelial layer is almost devoid of pigment. Right eye had a broad downward synechia, which had remained after an iritis six months ago. The fundus was tesselated as in the left eye, retina and vitreous were normal.....	When the patient came in the hospital, the disease had already flourished for fourteen days, and the retinitis as well as the hyalitis could be readily confirmed. The iritis was severe. The numerous fine synechiæ, however, were all torn. During the inunction course of treatment and four weeks after all external inflammatory symptoms had disappeared, a recurrence of the iritis suddenly took place. Five synechiæ were formed, which tore after several instillations of atropine.
15	R——, Kathrina..	30	Iritis o. dextri. Hyperæmia venosa retin. dextræ.....	Iritis, which was severe, commenced

No.	Name of the Patient.	Age—Years.	Disease.	Remarks.
				three weeks before admission of the patient: all the synechiæ were soon torn by atropine. The hyperæmia of the retina was observed at the same time as the iritis.*
16	F——, Magdalena.	17	Iritis, retinitis o. utr.....	When admitted the disease had just commenced. The inflammatory symptoms were unusually severe, and when they appeared almost subdued, there would suddenly spring up an exacerbation in one or the other eye. For ten months the patient was under observation. The retinitis was diagnosed in the first period of freedom from inflammation, *i. e.*, about seven months after the beginning of the trouble. The pupils could be irregularly dilated; firm but narrow synechiæ left a portion of the pupillary border free between them, and were situated so close to the periphery that a considerable retraction of even those portions of the iris having synechiæ was possible, and the undilated pupil appeared round. A very remarkable effect was the well-marked diminution of tension and the loss of refraction which occurred at the height of the inflammation. For a time the existing hypermetropia required +1·6 for correction, and at the time of the patient's discharge the refraction was emmetropic, and only after instillation of atropine there existed H 1·48 to H 1·30. At that time the left eye, which was more severely affected, had five and the right eye two isolated synechiæ. The pupils were round.
17	M——, Alexander.	47	Iritis o. sin.....	No complications.
18	B——, Maria.....	34	Iritis, hyalitis, retinitis o. utr....	The iritis commenced five days before admission of the patient. Eight days later the retinitis was diagnosed and eight days subsequent to this the hyalitis. The iritis was severe, and caused the formation of many fine synechiæ which readily gave way. The iritis was decidedly retrograding when the retinitis was discovered.
19	W——, Frida... ..	28	Hyperæmic irid. dextræ. Retinitis o. dextri.....	The affection first manifested itself in a disturbance of vision. This had already existed for several days, when pain, injection, and narrowing of the pupil set in. No synechiæ were formed. The external symptoms soon disappeared. Retinitis existed on admission.
20	L——, Josef.....	56	Iritis, hyalitis o. sin. Want of pigment in the epithelial layer.	The disease was four weeks old when the patient came under

* In two individuals with iritis of both eyes, in three with iritis of one eye, the ophthalmoscopic examination could not be made, partly on account of opacities of the pupillary space, partly on account of other conditions.

No.	Name of the Patient.	Age—Years.	Disease.	Remarks.
				treatment. Several firm synechiæ were found which permitted but a limited dilatation of the pupil, and could not be torn by the treatment. The floating bodies in the vitreous, and the fesselated appearance of the fundus of the eye were observed at the time the patient was admitted. On the right eye, as a residuum of an inflammation passed through seventeen years ago, there was an immense synechia taking up at least one-quarter of the pupillary border. Numerous floating bodies in the vitreous and extensive loss of pigment also existed, so that the fundus appeared regularly spotted. S=20-20. Since the subsidence of the iritis, the patient has never complained of that eye.
21	L——, Barbara....	32	Iritis, retinitis o. dextri.....	Duration of the severe iritis, fourteen days. Many synechiæ fix about two-thirds of the moderately dilated pupil. In consequence of numerous dotted deposits on the posterior surface of the cornea, it was impossible for a long time to make an ophthalmoscopic examination. Thirteen days after the admission of the patient I diagnosed the retinitis.
22	M——, Hirsch....	23	Iritis, retinitis o. dextri.....	When the patient came under treatment, the iritis had existed for three weeks. The inflammation was severe. The numerous fine synechiæ with one exception were torn. The retinitis was confirmed at the first examination.
23	I——, Josef.....	44	Iritis, traumatica o. sin.....	No complications.

Note.—In one of the cases belonging in this subdivision, the ophthalmoscopic examination could not be made on account of narrowness of the pupil, and also after iridectomy, on account of the uvea remaining adherent to the capsule of the lens.

From this table we readily deduce the fact that the presence of posterior synechiæ is not a cause of acute iritis. In four of the eyes treated, recurrences took place whilst the cases were still under observation. Of these four eyes, two at the time of the relapse were entirely free from synechiæ (cases 8 and 14), and two had isolated synechiæ, which, under ordinary circumstances, could exercise no influence on the movements of the pupil (case 16).

One patient was observed who had been treated in Breslau, eight years previously, for iritis of the same eye, which was now diseased, and who had been cured without any synechiæ remaining (case 5). Lues was the cause of the first as well as the second iritis.

In one patient severe iritis was observed in an eye which had circular synechiæ since ten years, and now suffered with severe neuralgia, marked ciliary injection, and knob-like protuberances of the iris. The other eye of this patient also had circular synechiæ which had existed for ten years, but, aside from this, looked perfectly normal, and had with a M. $\frac{1}{15}$ a S. $\frac{1}{20}$ (the patient was 70 years old). This eye, which could certainly be pronounced free from intra-ocular disease, was considered, until the commencement of the existing inflammation of its partner, as the worst eye of the two! There is no reason for supposing that the present iritis is the result of the existing synechiæ. The condition of the other eye forbids any such supposition. Among the above, I have mentioned a patient (case 20) whose left eye was affected seventeen years ago with iritis, and had retained a very large posterior synechia. Now the right eye became affected, and I am as unable to find the cause of this attack as of the first. As well as an irritation, productive of iritis, sometimes attacks one eye and, many years thereafter, the other, it may affect the same eye two, three, or even more times. And the necessity of finding another explanation for a repeated sickness of one eye, than for the affection which changes from one to the other, would only exist if statistics would show that an eye which had once suffered with iritis and retained synechiæ was more liable to a recurrence of the same trouble, than one which had been cured of an iritis without any synechiæ, or than one which had never had iritis; in short, if the majority or even a relatively considerable number of those cases which have retained synechiæ after an iritis were subject to a recurrent iritis. *Experience has taught me that eyes possessed of synechiæ are no more liable to relapses of iritis than those which have passed through an iritis without retaining any synechiæ*, and that the number of those eyes possessed of synechiæ, which enjoy undisturbed, comparative ease, is by far greater than the number of eyes similarly affected which in the course of years had to suffer from repeated relapses. The recurrence in these latter cases is therefore purely accidental, and we must remind the reader at this point that neither v. Graefe himself nor any of the later authors were able to find in the nature of the synechiæ themselves an expla-

nation for the deleterious influence which they ascribe to them.

The most remarkable fact demonstrated by the foregoing table is the *almost constant existence of retinitis with acute iritis.* The picture which the retina exhibits in these cases is that of retinitis diffusa. The papilla appears dirty, yellowish-red, very slightly or not at all transparent, with clouded edges. The retina surrounding it presents a greyish white or dirty, yellowish-red, opaque aspect. In the immediate neighborhood of the papilla the cloudiness of the retinal tissue is most dense, and very frequently attains such a degree that the choroid loses its influence on the color of the fundus oculi. Very rarely does the disease of the retina extend to the equatorial region; already, at the distance of 2-3 disk-diameters from the papilla, the cloudiness begins to clear up; from this point it gradually fades away, and at a distance of 4-5 disk-diameters from the margin of the papilla the retinal tissue appears perfectly normal. Circumscribed, large exudations are a rarity. In one single case (No. 13) was there a large, whitish exudation found, downward and inward from the papilla, and about 2 disk-diameters distant from it, the long diameter of which was more than half again as large as that of the papilla, whilst its width was about that of the papilla. In both eyes of another patient (case 12) there was originally diffuse retinitis, and gradually the picture changed, so that in both eyes the complicated appearance of an exquisite engorged papilla was presented, which differed in no respect from the common form resulting from tumor cerebri. In this patient we also had, on the external side of the papilla, in one eye, numerous white spots, arranged in the form of a disk, similar to the appearance in Bright's Retinitis. With the exception of lues, of which the patient was as thoroughly cured as it is possible to be by an energetic inunction treatment, there was no other anomaly present in the otherwise healthy country girl.

In the vascular system of the retina we do not see any remarkable changes, although it rarely presents a perfectly normal appearance. The dilatation and twisting of the veins are the earliest and most constant change. This attained in one case (No. 16) such a degree as is seldom seen, except in well-developed cases of engorged papilla. Once the cloudiness of the retina was

wanting altogether, and, besides redness of the papilla, there was only dilatation of the veins and an increase in the twisting (case 15), for which reason I diagnosed the case as one of hyperæmia venosa retinæ. No change can be found either in the course or the diameter of the arteries. They are generally very indistinct, and in the examination of the inverted image, when using a lens of 2″ focal distance, we sometimes became impressed with the idea that the retina had only veins. In the patient with the engorged papilla of both eyes, I saw numerous fine vessels on the papilla, wound like a corkscrew, and with several loops projecting into the vitreous, similar to those v. JÄGER has pictured in his ophthalmoscopic hand atlas, on Plate 15, Fig. 72, and called "New Formation of Blood-vessels in the Vitreous." In only one instance (case 21) did I see a small blood extravasation running in a radiating direction.

The above-described group of pathological changes of the retina is that known under the name of retinitis specifica. But we are as little able to form a group of symptoms, or to mention even a single symptom, by which we can positively determine a specific from an idiopathic retinitis as we are to form the same for iritis. We are gradually coming to the conclusion that, in the pathology of the different forms of retinitis, too great stress has been laid on accidental appearances, and an extensive experience gradually but steadily teaches us to abandon the classification of ophthalmoscopic pictures according to the cause. The retinitis specifica, for instance, has the least prominent characteristics; it is impossible to distinguish between the ophthalmoscopic picture it presents and that of the non-specific diffuse retinitis. Among the above cases, it has happened even that the deviations from the picture of retinitis diffusa occurred just in three eyes affected with retinitis specifica. The argument might be made, for the purpose of keeping the special classification for pictures of disease, that the cases of retinitis observed by me in syphilitic individuals do differ from those usually classed under the heading of "retinitis specifica," and, as the cases of retinitis in non-syphilitic individuals, should be considered as cases of retinitis depending alone on the iritis. But these cases do not differ at all from those cases of retinitis specifica which occur without iritis, and these again resemble

entirely the diffuse retinitis which occurs from different causes without iritis. We can, therefore, only speak of a retinitis diffusa, which may be due to the one or the other cause, but not of a retinitis specifica, nyctalopica, iritidem concomitans, etc.

The loss of vision due to retinitis is often very slight. In cases in which the media had remained clear, it was not uncommon to find S. $\frac{20}{30}$, nearly $\frac{20}{20}$; only a weakness, uncertainty in seeing, and irregularity of the acuteness of vision at different times were observable. Yet there are cases in which, notwithstanding clear media, S. has sunk to $\frac{20}{50}$, and even over. Central scotomata I found in specific retinitis, just as Förster has described them; occasionally I missed them altogether, and again found them in non-specific retinitis. The examinations made with regard to this single point are, however, too few to allow me to express an opinion as to the relative frequency of central scotoma in syphilitic retinitis.

The influence of diminished illumination on the acuity of vision I could examine only in a few cases. I was without the apparatus which Förster used in his investigations, and only lately discovered a means which would enable us to dispense with it altogether. The method which I employed I will describe here, although the examinations made in this manner are too few to offer a sure basis for drawing conclusions. I used a little arrangement which consisted of a short, metallic cylinder, having a rotary movement in a ring embracing it. This ring rests on a massive wooden stand, to which it is firmly attached, in a direction perpendicular to the axis of the cylinder. I give this stand to the patient, and with it he holds the cylinder in such a manner, before the eye to be examined, that an open end of the same, especially cut to fit, applies itself to the orbital margin. The end of the cylinder so applied has, besides this, a border of black cloth, projecting on all sides, which is laid in such a manner that the possibility of light falling from the side in the eye to be examined is avoided. In the centre of the cylinder is a partition, perpendicular to the axis, and having a central aperture; after having determined the visual power of the person to be examined, by allowing him to look in daylight at the test types of Suellen, the opening of the partition is covered first with

one, then two, three, and at last four, dark glass plates. The dark plates must be uniformly thick and uniformly colored, and possess plain parallel surfaces. After placing the first plate, I waited five minutes, and examined the visual power; then, without allowing the patient to remove the cylinder from the eye, I introduced a second plate, and determined, after waiting further five minutes, the visual power then existing, etc. By comparing the acuity of vision found in this manner with that which, under similar conditions, I found in normal eyes, I believe I have found a useful method to determine the influence of the intensity of light on the visual power. The simplicity of the entire procedure, together with the convenience and clearness of the manner of expression, seems to me to recommend it for general use. I found that my own S., which, with good illumination, amounts to $\frac{24}{xx}$, was not changed by placing one of the glass plates into the apparatus, since I was able then, although with difficulty, to recognize xx. in 24′; by inserting a second plate, my S. was reduced to $\frac{24}{xxx}$, by a third to $\frac{24}{lxx}$, and by a fourth to $\frac{24}{c}$. If I take this as a standard, and the S. by good daylight as the unit, then the S. through one dark plate = 1.00, through 2 = 0.66, through 3 = 0.28, and through 4 = 0.10.

In case 19, I found, in non-specific retinitis with central scotoma, and without opacities of the vitreous:

On June 8th, 1875, S. $\frac{1}{60}$, after introducing 1 dark plate, S. = 1.00,
" " 2 " plates, S. = 0.70,
" " 3 " " S. = 0.25.
On June 13th, 1875, S. $\frac{1}{60}$, after introducing 1 dark plate, S. = 1.00,
" " 2 " plates, S. = 0.70,
" " 3 " " S. = 0.25.
On June 19th, 1875, S. $\frac{1}{30}$, after introducing 1 dark plate, S. = 1.00,
" " 2 " plates, S. = 0.60,
" " 3 " " S. = 0.43.
On July 3d, 1875, S. $\frac{1}{30}$, after introducing 1 dark plate, S. = 0.75,
" " 2 " plates, S. = 0.60,
" " 3 " " S. = 0.43.

In case 21, of non-specific retinitis, without central scotoma, and without opacities of the vitreous, we found:

On June 19th, 1875, S. $\frac{1}{10}$, after introducing one dark plate, S.

was 1.00, after introducing two dark plates, S. was 0.35, after introducing three dark plates, S. was 0.01.

On June 23d, 1875, S. $\frac{1}{40}$, after introducing one dark plate, S. was 0.80, after introducing two dark plates, S. was 0.40, after introducing three dark plates, S. was 0.01.

On June 28th, 1875, S. $\frac{1}{40}$, after introducing one dark plate, S. was 0.80, after introducing two dark plates, S. was 0.40, after introducing three dark plates, S. was 0.01.

On July 4th, 1875, S. $\frac{1}{30}$, after introducing one dark plate, S. was 0.75, after introducing two dark plates, S. was 0.40, after introducing three dark plates, S. was 0.01.

On July 21st, 1875, S. $\frac{2}{40}$, after introducing one dark plate, S. was 0.80, after introducing two dark plates, S. was 0.40, after introducing three dark plates, S. was 0.01.

On July 29th, 1875, S. $\frac{2}{40}$ + F. H., after introducing one dark plate, S. was 1.00, after introducing two dark plates, S. was 0.57, after introducing three dark plates, S. was 0.20.

In case 14, specific retinitis, without scotoma, and with fine, dust-like opacities of the vitreous, we found:

On June 14, 1875, S. $\frac{1}{30}$, after introducing one dark plate, S. was 0.43, after introducing two dark plates, S. was 0.43, after introducing three dark plates, S. was 0.003.

On June 17th, 1875, S. $\frac{1}{40}$, after introducing one dark plate, S. was 0.80, after introducing two dark plates, S. was 0.57, after introducing three dark plates, S. was 0.08.

On June 19th, 1875, S. $\frac{2}{40}$, after introducing one dark plate, S. was 0.80, after introducing two dark plates, S. was 0.20, after introducing three dark plates, S. was 0.01.

On July 6th, 1875, S. $\frac{2}{30}$, after introducing one dark plate, S. was 0.75, after introducing two dark plates, S. was 0.43, after introducing three dark plates, S. was 0.06.

On July 21st, 1875, S. $\frac{2}{30}$, after introducing one dark plate, S. was 0.75, after introducing two dark plates, S. was 0.50, after introducing three dark plates. S. was 0.20.

In case 7, with specific retinitis, small, eccentric scotoma, and dust-like opacities of the vitreous, we had:

On June 8th, 1875, S. $\frac{8}{30}$, after introducing one dark plate, S.

was 0.75, after introducing two dark plates, S. was 0.42, after introducing three dark plates, S. was 0.10.

In one patient, who had specific retinitis without iritis in the right eye, and a central scotoma and dust-like opacities of the vitreous, whilst the left eye was normal, I found, on June 9th:

R. eye: S. $\frac{20}{30}$; L. eye: S. $\frac{20}{20}$; after introducing one dark plate, S. was 0.75 and 1.00, after introducing two dark plates, S. was 0.30 and 0.50, after introducing three dark plates, S. was 0.05 and 0.10.

I desist from discussing these results, because they are too few, and also because the number of examinations made on normal eyes is too small to be used as a standard for comparison.

The frequency of retinitis diffusa in eyes affected with iritis is a remarkable one. Among 16 eyes having specific iritis, I found only one normal retina, and among 10 having non-specific iritis, only 3. If even these numbers are too small upon which to base a law, they certainly justify the remark that the probability of retinal complications is not materially increased by the existence of syphilis.

Usually the retinitis appears simultaneously with or shortly after the beginning of the iritis. Occasionally we have iritis alone in one eye, and iritis and retinitis in the other (case 14); then again, in the one eye retinitis only, and in the other, both iritis and retinitis (cases 1 and 12). Sometimes the disease of the retina precedes that of the iris (case 19). One case, which illustrates well the relations of the retinitis to the iritis, and which I observed years ago, I will briefly relate.

R——, John, 41 years old, was treated in the summer of 1867, in the eye wards of the general hospital, for specific iritis of both eyes, and was discharged as cured, without synechiæ, on June 3d. The ophthalmoscopic examination made at that time showed no anomaly. Three weeks after the discharge of the patient, he returned, and we found in both eyes "light, diffuse opacities of the vitreous, and infiltration of the retina." Ten days after this examination, he was readmitted to the hospital with very marked diffuse retinitis. The formation of floating bodies in the vitreous followed, which increased with remarkable celerity, both in number and size, and which reduced the visual power from $\frac{20}{30}$ to the possibility of recognizing the movements of the hand at 1′ distance. Six weeks after

the commencement of this new trouble, the iris of the left eye, which had remained sound so far, began to inflame. After fourteen days, the iritis was relieved. The opacity of the vitreous receded slowly, and, four months and a half after the entrance of the patient (Nov. 13th, 1867), he was discharged with S. $\frac{20}{40}$ in the left eye (in the right eye he had a congenital amblyopia). The disk at that time was "reddened, slightly opaque, but indistinctly defined. Vessels of normal size. In the vitreous, several large flakes, which are united by thin threads and move together." In the choroid there was nothing abnormal; the iris appeared normal again. On the 16th of February, 1868, I found the external appearance of the eyeballs normal. With the ophthalmoscope I saw in both eyes diffuse and flaky opacities of the vitreous developed to such a degree that it was impossible, except with much trouble, to recognize anything of the fundus; I was able, however, to diagnose a contraction of the retinal vessels. He could read Jäger, No. 13, with either eye. A finely-made iridectomy did not change the condition.

The severity of the iritis has as little influence on the determination of a retinal complication as the nature of the iritis. The lightest form of iritis can be complicated with retinitis, and the most severe forms can be free from it. The occurrence of the retinitis is not, therefore, the result of the irritation produced by the iritis, nor can it be regarded as an expression of the progress of the inflammatory irritation; on the contrary, the irritation produces the disease in the iris and retina simultaneously. Both are due to a common cause; each one is independent of the other.

The retinitis always lasts longer than the iritis. In not a single case had the retinitis been entirely cured at the time that the patient had to leave the hospital. In cases 7 and 10 I saw the retinitis in full bloom ten months after the iritis had entirely disappeared. The last patient considered herself perfectly well; notwithstanding the beautifully developed engorged papilla, S. was almost $\frac{20}{20}$ in either eye. The first patient had S. $\frac{20}{30}$ and a small, eccentric scotoma which diminished very slowly.

The vitreous showed evidences of disease in only seven of the twenty-six eyes suffering with iritis, which I examined ophthal-

moscopically. It is less frequently attacked than the retina. Where the vitreous participated in the trouble, however, the retina was almost always affected, for in seven cases of hyalitis only one escaped a retinitis (case 20). Four (cases 6, 7, and 14) of the seven eyes had specific, and three (cases 18 and 20) non-specific iritis. Three of the first four and two of the last three had that peculiarly formed opacity of the vitreous which FÖRSTER declares characteristic for the specific retinitis.* Numerous dark, dust-like to granular points, standing closely together, were seen arranged either on a flat surface in lumps, or like globes. When the eye was in a quiet state, I always found this collection in the same situation. With the movements of the eye, these moved in such a manner that their relative position was unchanged, so that we were led to believe in the existence of a net-like membrane, in whose meshes these points were fixed, and the threads of which were invisible. In one eye (case 14) suffering with syphilitic iritis, and in one (case 20) suffering with non-syphilitic iritis, I found opacities of the vitreous of an irregular, ragged appearance, and of different size and density, which were not entirely free, but were movable inside of a certain space; and when the eye returned to a state of rest, these returned to their original position. Thus this class of cases demonstrated anew to me that changes in the vitreous are not a constant symptom of syphilitic retinitis, nor is their form characteristic of a syphilitic affection, a fact of which I had before thoroughly convinced myself.

That opacities of the vitreous do occur with iritis is well known; the usual explanation of their origin is a wrong one. "We are accustomed to speak of choroiditis when the vitreous is cloudy" (*Mautlner*, Lehrbuch der Ophthalmoscopie, page 431). *Zehender* says that "Opacities of the vitreous originate very rarely in the vitreous body itself" (Handbuch der gesammten Augenheilkunde, 2 Aufl., 2 Bd., page 539). Only *Schweigger* remarks, after having mentioned that we are accustomed to think of choroiditis or cyclitis as soon as vitreous opacities are seen, even when the ophthalmoscope shows no choroidal changes, "that there is no reason existing why the cellular elements of the vitreous should not be affected independently, as, for instance,

* Förster, Archiv. f. Ophth., XX.

those of the cornea" (Handbuch der spec. Augenhlkde., 3 Aufl., page 409). The explanation which I give of those opacities of the vitreous which occur with iritis has been clearly shown in the diagnosis of hyalitis, which I have made in the cases mentioned.

Let us consider this subject apart from the theory recognized as correct, and let us enquire what reasons could impel us to look upon a change in the vitreous, without any pathological symptom in the choroid itself, as a symptom of disease of the choroid. I do not believe that any other could be found than that we still have a certain reluctance to acknowledge inflammations possible in a non-vascular tissue, and that, in cases of demonstrable choroiditis, opacities of the vitreous are an almost constant attendant.

There are certainly very few ophthalmologists who agree with the opinion of *Desmarres* and *Galezowski*, which culminates in the following sentence: "Cette humeur est un liquide semblable, selon M. Robin, à du blanc d'œuf, et tout à fait incapable de s'enflammer (Études sur les flocons du corps vitré; Annales d'Oculistique, 1864, S [illegible], p. 71). The possibility of inflammation of the vitreous is now almost universally acknowledged. Not long ago I examined an eye which for almost thirty years had had a *staphyloma corneæ fere totale*, and which suddenly and without any assignable cause was attacked with an unusually severe and painful inflammation. In this, after hardening in Müller's fluid, the entire vitreous was found changed into a single firm globe of pus, which could be removed from the hemisphere of the eye as cleanly and as coherently as the yolk from its white mantle in a hard-boiled egg. The choroid was not thickened nor adhering to the retina or sclerotic; its largest vessels, the capillary layer, the stroma cells, and pigmentary layer were well preserved. Only numerous pus cells were scattered in the tissue, but in no place were they in such quantity that they covered the tissue or were arranged in layers upon it. The retina, however, was entirely disorganized, thickened to three or four times its size, and completely saturated with pus cells. In seeing such eyes, we rather suppose the affection of the vitreous in direct connection with that of the retina than dependent upon that of the choroid; but it would be more correct to grant that purulent

inflammation may exist at the same time in the retina and in the vitreous, independent of each other.

In cases in which an injury has occurred to the vitreous, we can see and follow the inflammatory products with the ophthalmoscope; and their locality and form, on the one hand, and the condition of the choroid, on the other, thoroughly convince the observer that he has to deal with an independent inflammatory process originating in the vitreous. When, at the same time, in such cases hemorrhages have taken place into the vitreous, the hemorrhagic opacities can readily be distinguished from those caused by the increase of the inflammatory tissue; and if, in the formation of a cord or lump found in the vitreous, extravasated blood and new tissue have entered, we can, with the ophthalmoscope, follow the gradual disappearance of the extravasation whilst the other parts remain. Notwithstanding this, *Zehender* lays so little stress upon the vitality of the vitreous that, granting the possibility of another origin, to which he had been forced by anatomical investigations, he still declares the choroidal hemorrhages as the usual cause of opacities in the vitreous (l. c., p. 538).

Suppurative hyalitis, as well as hyalitis in the vicinity of a perforating foreign body, or after rupture of the vitreous during an operation, are now almost universally acknowledged; yet the most common form of hyalitis is looked upon only as a symptom of choroiditis. Even in such cases, where undoubted signs of choroidal disease exist, or had existed previously to the commencement of the opacities of the vitreous, we cannot understand how, through the unchanged retina and hyaloid, pathological products —which, in their position as well as their form, bear the stamp of their origin, depending on the place in which they exist—can reach the vitreous from the choroid. As often as I have made anatomical examinations of vitreous opacities, I have found, aside from the suppurative hyalitis, cellular elements, such as are found neither in the blood nor in the normal or diseased choroid, but in small numbers in the normal vitreous humor. Hemorrhages from the retina or the choroid are but rarely the cause of opacities of the vitreous; and *Wecker*, as well as *Zehender*, certainly overestimates the frequency of this occurrence when he says:

"Une des sources les plus fréquentes des opacities du corps vitré . . . . . réside dans les épanchements de sang qui s'y opèrent" (Traité des maladies des yeux, II édition, tome second, p. 278).

According to the prevailing opinion, the vitreous plays almost only a passive part, though the possibility of its becoming inflamed is admitted. Since this inflammation is considered dependent on uveal or retinal diseases, or the vitreous is regarded as a mere receptacle for choroidal exudations and extravasations, it is easily explained why choroiditis is diagnosed in cases in which absolutely no change can be demonstrated in the choroid, and that the tissue in which the most marked and numerous anomalies are found is ignored in determining the nature and nomenclature of the disease under consideration. But the most marked diseases of the vitreous are frequently found without any coincident choroidal affections. I have observed many cases in which, within a few days or hours, nay, even suddenly, the vitreous chamber would be so completely filled with opaque, large opacities that normal visual power would be reduced to quantitative perception of light, and yet, after a gradual disappearance of the pathological products, the choroid would be found normal. That the choroid shows no changes in acute glaucoma, after clearing of the media, either spontaneously or by an iridectomy, cannot be adduced as a self-evident proof of the possibility of an exudation from the choroid into the vitreous without any visible sign of an affection of the choroid. *Schweigger* says that he has never been able to demonstrate the presence of a diffuse opacity of the vitreous in acute glaucoma (Hdb. d. sp. Augenhlkde., 3 aufl., p. 519). I can say that I have fully convinced myself that in acute glaucoma an opacity of the vitreous does not exist.

An exquisite case of hyalitis, without any choroidal affection, is at present under my observation, and I may be permitted to give a sketch of its history.

G., Henry, 32 years old, received, on the 1st of April, 1874, a blow with the open hand in the region of the right eye. In consequence thereof, the visual power of this eye sank suddenly, and was lost so quickly that on the 3d of April the patient was unable to go about alone. The opacity of the vitreous, which proved to be the cause of his impaired vis-

ion, disappeared after an inunction treatment, so that on the 16th of May S. was $\frac{20}{30}$. From that time the vision of the patient, who was no longer under treatment, continued to improve until the commencement of August, 1874, when, in consequence of a cold, sudden blindness again set in. The ophthalmoscope demonstrated the existence of the same cause as in the first sickness, and the same treatment restored the patient so much that on October 27, 1874, S. was again $\frac{20}{30}$, and we were able, with Jäger's weak-lighted ophthalmoscope, to observe the details of the fundus. On the 13th of June, 1875, the patient was first observed by me; the above-mentioned notes I took from the archives of the eye department. Until the 11th of June, 1875, the patient was perfectly satisfied with his power of vision. Two weeks previously, an oculist of this place had examined the patient, and declared the right eye, with the exception of a few slight opacities of the vitreous, to be entirely normal. On the 11th of June, about 7 P. M., "something like a black drop" came suddenly across his right eye. This spread in every direction very rapidly, and destroyed the visual power. On the 13th of June, at 9 A. M., I saw the patient for the first time. At that time he was able to count fingers, with great difficulty, at 9′, and then only by making rotary or shaking movements of the head. Extensive opacities in the vitreous rendered the observation of the fundus of the eye totally impossible. The opacities were membranous, with sharp edges or ragged boundaries, and occupied, in several layers, all the parts of the vitreous. Inward and upward I could discern in the vitreous two greenish-white, very brilliant patches.* The

* Such peculiar formations in the vitreous I have seen several times. They all have the white color, the strong. greenish reflection, and the sharply-defined form in common. They are much larger, denser, and more sharply separated from the surrounding tissues than the ordinary vitreous opacities. They are fixed, without our being able to determine what keeps them so. On one occasion I saw, in an otherwise healthy eye, such a pear-shaped body. with finely-drawn points, floating in the centre of the vitreous. In one patient, with embolism of the retinal artery, such a patch, with a stem-like projection, was seen attached to the surface of the papilla, and projected, with a swollen, club-like end, into the vitreous. In a patient with neuro-retinitis I saw a solid, opaque, greenish, shining ball swinging in the upper portion of the vitreous. From its upper surface, a horizontal and a vertical process, with a knob-like ermination, extended into the vitreous.

Once I observed such peculiar opacities of the vitreous under highly remarkable conditions. W., John, aged 20 years, became blind from October, 1874, to January, 1875, in the left eye, without the slightest external symptoms of inflammation. In January, 1875, the left eye had only quantitative perception of light. Then the sight improved, and the patient asserted that he saw tolerably well in February, 1875. Then, suddenly, over night, and without any known cause, the condition of the eye got

one was cup-shaped, and had its concave surface turned forward. On it I discovered twisted, thin vessels, whose origin I could not determine. The other spot, situated under the first, was a long, staff-like, pointed body, of the same brilliancy and color as the first, but without vessels.

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worse again, and on the 10th of March, 1875, I found impenetrable opacities in the vitreous, and fingers could be counted only in 5'. Under the inunction treatment, the eye again cleared up, and on April 13th S. was $\frac{20}{70}$. At that time I saw, besides isolated, stringy opacities, so common in the vitreous, a narrow, sharply defined, light-colored curve lying upon the retina, and parallel to, but a short distance from, the outward papillary margin, which resembled a choroidal rupture, but covered the retinal vessels. Another somewhat similarly formed opacity was united to this with its two ends, and was stretched through the vitreous, above the level of the retina, about $\frac{3}{4}$ diameter of the papilla distant from the disk. From the point where these two curves were united above the papilla, a simple, curve-shaped stripe took its course, at first lying upon the retina, then gradually lifting itself more and more from it, and entering the vitreous, for a short distance parallel to the upper margin of the disk, and then it dropped in front of the papilla, to continue its course below the lower papillary margin to the lower point of union of the first two curves next to the outer margin of the disk. At this point, after it had spread itself in the shape of a leaf, it became united. The entire formation lay like a ring placed at an acute angle to the axis of the eye, and was almost immovable. It had a beautiful, pearly-white appearance when not illuminated by the transmitted light. A tolerably large artery, which ran outward and downward, gave off a branch at a point about $\frac{1}{2}$ disk-diameter distant from the margin, which pushed forward into the vitreous until it reached this white formation, when it turned upon itself, forming a bow, the length of which equalled a third of the disk-circumference, stretching downward and inward, with the concavity turned toward the papilla. From the convex side of this bow a number of branches were given off, every one of which formed a loop, running a short distance backward and turning forward again, thus forming several loops, lying like the fingers, close to one another. In no place could I see a vessel ending free; everywhere loop-like turnings only. A communication of this vascular pencil with other vessels I could not see; on the contrary, in following up any single vessel, I always came back to the same retinal artery. No vein corresponded to this collection of arterial vessels. These vessels formed a many-branched terminus of the arterial current. They all lay next to one another in the above-mentioned, leaf-like expansion of the white patch in the vitreous. When the eye was quiet, the thin, perfectly smooth membrane, with its sharp, not incurved, margins, lay horizontally in the vitreous, one surface turning directly upward, the other directly downward. If the eye moved, the membrane rose and sank; the vessels, however, did not change their relative positions. In order not to omit any of the peculiarities of this case, I must mention that one of the principal veins, coming from below and outward, had, near the hilus nervi optici, a beautifully-defined, spindle-shaped, varicose intumescence. The papilla was reddened, its margins were somewhat indistinct, the retinal veins abnormally large. In the choroid there was not the slightest deviation from the normal condition. From the 24th of January till the 5th of May I examined the eye frequently, and found the peculiar new formation in the vitreous and the vascular anomaly unchanged.

Tension and external appearance of the eyeball were altogether normal. A fresh inunction treatment was commenced. On June 17th, in the morning, the number and density of the vitreous opacities had considerably decreased; I could already distinguish the situation of the papilla with the weak-lighted ophthalmoscope (Jaeger), in the erect image, and S. was $\frac{1}{40}$. The clearing proceeded at first very rapidly. On June 22d, S. was $\frac{1}{30}$. On the 1st of July I was able to recognize in the erect image the outer darkly-pigmented margin of the papilla, and at least surmise the position of the arteries. On July 3d I could see the boundaries of the papilla on all sides, and recognize the entire vascular system. S. was $\frac{2}{40}$. On July 24th, S. was $\frac{2}{30}$. The opacities were still numerous, but thin, perforated in a number of places, not sharply-defined, and very movable. The light greenish-white spots remained the same in form, size, and position; they were immovable. I could still see the vessels as light red streaks or twisted like a knot of fine lines, but, notwithstanding all imaginable painstaking, I could not follow them beyond the white spots into the neighboring vitreous. The retina and choroid remained *perfectly normal*. On August 1st I saw the patient for the last time; the condition was unchanged.

Is it to be supposed that the severe affection of the vitreous, appearing so suddenly three times, should be but a symptom of choroiditis, although the choroid maintained its normal appearance? The rapid impairment of the vision, synchronous and commensurate with the affection of the vitreous, and its steady and regular improvement, corresponding to the decrease of the affection in the vitreous, are sufficient in themselves to convince us that we had to deal with a difficulty in the vitreous alone.

Thus vindicating an independent position for the vitreous body, a more thorough study of its pathology will doubtless throw new light upon its anatomical structure, which is still so little known. I am confident that the constancy in the development and course of certain opacities of the vitreous is due to the histological structure of the vitreous, and that, by careful observation and comparison, we shall obtain further evidence of the probable existence of a framework in it. I believe that some questions of general pathology, for instance, the part which the cellular elements play in inflammatory processes, the formation of pus,

etc., may be considerably elucidated by investigations on the alterations of the vitreous body.

A more extensive study of the diseases of the vitreous will doubtless clear up, also, some of the many still existing contradictions and dark points in special ophthalmology. Now we diagnose choroiditis in case of considerable increase of the vitreous substance, as manifested by increased tension, even when there is no opacity of the vitreous, as in glaucoma; and then, again, we diagnose choroiditis in a case where there is a demonstrable diminution of the vitreous substance, manifested by a reduced tension, and which is produced by the collection of a pathological product between the choroid and retina, as in detachment of the retina. We speak also of choroiditis, when, without increase of tension, large vitreous flakes are formed, as in the above described case, and then again when, with considerable loss of tension, we have an unusual amount of opacities in the vitreous, as in many cases of irido-cyclitis; when, without visible changes in the choroid, the vitreous fills with opacities, and then again when, with extensive choroidal anomalies, the vitreous remains clear, or only a few finely flaked opacities are seen!

It is unconditionally necessary to separate the diseases of the vitreous body into those of the vitreous fluid and those of the formed elements. The first are generally but anomalies of quantity. They can be divided into increase of the vitreous fluid, as we see it in glaucoma, and into decrease of the same, as it is observed in essential phthisis and detachment of the retina. Whether qualitative anomalies of the vitreous fluid exist, I am not prepared to state. So probable as this, at first sight, seems to be, and notwithstanding that diffuse opacity of the vitreous is so frequently diagnosed, I must acknowledge that my experience in acute glaucoma has made me diffident, and I will therefore await further observations before again speaking of diffuse opacities in the vitreous. The anomalies of the formed elements are both of quantity and quality. As in the common form of hyalitis the number of cells of the vitreous largely increases, so in the synchysis of the vitreous humor it is highly probable that they decrease. Anomalies of quality are furnished by the appearance of pus cells, cholesterine, fat, etc. Each of

these anomalies can exist alone, or in combination with others, either with or without simultaneous disease of the tunics of the eyeball.

Alterations of the choroid were found only four times in twenty-six cases of acute iritis. They all occurred simultaneously with the hyalitis, and consisted in a more or less extensive atrophy of pigment in the epithelial layer. The deficiency of pigment was uniform in a given region, and never accompanied by circumscribed accumulations of pigment, in the four eyes belonging to three individuals, of cases 6, 14, and 20. In the two persons affected only in one eye (cases 14 and 20) I found a similar deficiency of pigment of the same size and degree in the sound eye. The fellow eye, it is true, had suffered from iritis, in case 14, six months, and, in case 20, seventeen years previously, and still bore traces of it, but one eye had S. $\frac{20}{15}$ and the other $\frac{20}{20}$. Yet it is very remarkable that I have never observed this want of pigment in one eye only, but always in both, and of the same extent, although they had been affected in different degrees and at different times. Since we meet with this deficiency of pigment very frequently, in otherwise perfectly normal eyes, especially in old people, we should be very careful in considering as pathological this regularly tessellated appearance of the fundus, particularly when it exists without any patches of pigment or morbid formations, and I, for one, never consider it as a symptom of disease when it is isolated. Its existence in some of the eyes above described was, I think, not a symptom of choroiditis, but purely accidental, either preceding or succeeding the inflammation, but standing in no relation whatever to it, and thus I come to the conclusion that a *complication* of choroiditis could never be substantiated as existing in any of the twenty-six eyes suffering with acute iritis which I examined.

From the foregoing the following inference is evident: when, some time after the termination of the original iritis, and without any relapse having taken place, the vision begins to decline, then the retinitis and hyalitis which accompanied the iritis did not improve with it, but slowly aggravated, and caused the amblyopia. An opportunity of examining such eyes is not frequently

afforded, for with the cessation of the iritis, the great majority of eyes which were so affected return to a condition of relative health. The intra-ocular complications which had existed in these eyes abate slowly, and in those cases in which amblyopia follows at a later period, an ophthalmoscopic examination is commonly impracticable. In the past year I have only seen three patients who applied for treatment of a progressive amblyopia in consequence of an iritis, and whose pupils were free. It is important to know the history of these cases.

1. N., Alexander, aged 22 years, was treated by me from September 28 until October 30, 1869, for an iritis of the right eye, the cause of which was not known. He was dismissed with several filiform synechiæ and a very thin pupillary membrane, pierced at different points. The condition of the patient's sight after the iritis was not noted in his history. In the year 1870, however, he felt at times a certain discomfort in the right eye, which was free from any inflammation, and noticed a slight diminution of sight. As, in the spring of 1871, the trouble in the right eye increased, the patient consulted an oculist, who proposed iridectomy, an operation to which the patient did not submit until it was again advised at Arlt's clinic, where he had also applied. At this clinic the operation was performed on the 5th of April, 1871. Before the iridectomy, R. S.=$\frac{20}{40}$, L. S.=$\frac{20}{30}$. The pupil of the right eye was occluded by a membrane, which had an opening superiorly; the iris was attached to the capsule by synechiæ; fundus normal. The left eye was normal. The iridectomy did not prevent the progress of the disease. In 1874, while the sight of the right eye was still diminishing, the sight of the left eye also became impaired. On the 15th of March, 1875, an oculist of this city diagnosticated opacities of the vitreous in both eyes. At that time the patient read with the right eye No. 1 at 2″, with the left eye at 5″ (in both cases M.=$\frac{1}{6}$ without conus). On the 22d of July, 1875, *i. e.*, six years after I had treated patient for the first iritis, I saw him again. R. S.=$\frac{20}{100}$, L. S.=$\frac{20}{50}$. In the right eye I found a large coloboma above, through the periphery of which the edge of the lens could be seen. The fixed parts of the pupillary edge were attached by numerous thin, white synechiæ; the pupil was round and clear; the iris presented a normal appearance; anterior chamber normal. In the vitreous body there was a massive network composed of broad bands, which, when the eye was at rest, retained their mutual relations, but when it was moved, they separated and floated apart. The papilla was pale and slightly clouded, as were also

the surrounding portions of the retina. The retinal arteries could not clearly be seen, and were smaller than normally, whilst the retinal veins were abnormally large. The choroid showed nothing whatever of a suspicious character. The pupil of the left eye, into which, four days before, atropine had been dropped, was moderately dilated, and at its edge there were three new, very thin, filiform synechiæ. The pupillary area was perfectly clear, iris and anterior chamber normal. In the vitreous there was a large number of bodies as described above. They were attached to the lateral portions of the vitreous cavity; some of them were in lumps, some shell-shaped, others trabecular. One of them resembled the branch of a tree, dividing dichotomously. Besides these, there were many ribbon-shaped opacities of the vitreous, of the usual aspect. The retina and choroid were the same as in the right eye. The paleness of the papilla was marked.

This case is exceedingly instructive. It teaches us (1) that a comparatively light iritis, independently of the relapses of iritis, may be followed by grave secondary lesions; (2) that these may be caused by an insidious hyalitis and retinitis, which may progress while the choroid is intact; (3) that even the ideal of iridectomy is not always able to prevent the marked tendency to progress of intra-ocular disease consequent on iritis, even if at the time of the operation the intra-ocular changes are slight; (4) that the iritis, retinitis, and hyalitis may occur in a reversed order of succession. The latter fact is, as I believe, of importance, because it shows that the development of synechiæ may be directly attributed to the existence of *intra-ocular disease*.

2. S., Mary, aged 48, suffered three years ago from a very severe iritis of the left eye, the cause of which is not known. Eight months after the first attack she had a second, which was followed two years later by a third. Eight days before I saw the patient for the first time (on the 18th of July, 1875), the diminution of sight, consequent upon the inflammation of the left eye, was increased in the left eye, and also appeared in the right eye, which up to that time had been unaffected. I found the pupil of the left eye round and very movable; there were three narrow synechiæ, which, however, did not influence the shape of the pupil. The pupil of the right eye was normal. Both irides appeared to be normal. The vitreous of both eyes showed large, dark flakes, which, during the

movements of the eyes, would at times appear white. In the left eye this new formation existed in such quantities that it simulated detachment of the retina in certain positions of the eye. The reflex of the fundus became strikingly gray. The papilla and retina were normal, fundus on both sides regularly pigmented. The notes on the condition of the inner membranes are only based on the rather unreliable inverted image, the impatience of the patient rendering an accurate examination impossible.

This case shows that iritis may recur even when the synechiæ are not of a nature which is generally thought to be dangerous; it is of importance, furthermore, because, as in case 1, the hyalitis appeared in the eye which had been free from the iritis, after existing in the other for some time.

3. H., Veronika, aged 37. The exact time at which acute iritis existed in both eyes cannot be established. From her statement we can only deduce with certainty the fact that already fifteen years ago small clouds and seed-like spots, gradually increasing in number, filled the visual field. Sight had been slowly diminishing since many years. Syphilis has never been present. On the right eye we find seven distinct filiform synechiæ, which generally have no influence on the shape of the pupil. The pupil reacts upon the admission of light, and only when dilated shows the synechiæ, which are inserted into the posterior surface of the iris at some distance from the pupillary margin. In the vitreous body there are numerous dark points, which range themselves in several planes, vertical to the axis of the eye, when the eye is at rest, and only slightly mar the distinctness of the image of the fundus. Papilla and retina are exceedingly turbid and reddish-yellow, the arteries narrower than usual. This eye is just able to count fingers at six feet. The lower half of the pupillary margin on the left side is attached to the capsule by a white semicircular band; from above a strong, wedge-shaped synechia projects. An instillation of atropine causes only the lateral boundaries of the synechia to retract. In the vitreous body there are a few movable flakes. The retina and papilla are similarly, but less markedly, changed than in the right eye; S. $= \frac{2}{20}$, with difficulty. In neither eye is there any abnormity of the choroid.

In both eyes the intra-ocular changes are inversely proportional to the volume of the synechiæ, and, though the affection of the vitreous body and the retina has lasted fully ten years, and

the loss of sight in the right eye is so very marked, there is no change whatever in the choroid.

In cases in which there was occlusion of the pupil with progressive loss of sight, the shape and tension of bulbus being normal, and an iridectomy well executed had enabled me to make an ophthalmoscopic examination, I observed more or less atrophic changes in the retina and the optic nerve; besides very frequent opacities of the vitreous.

From September 8th, 1868, until February 18th, 1869, a woman was treated in the eye department of the "Allgemeine Krankenhaus," who showed a very well developed irido-choroiditis, which had lasted for years and was of a specific nature. The iris on both sides was discolored, traversed by dilated vessels, pushed forward to the posterior surface of the cornea, sloping in a funnel-like manner toward the occluded pupil. The sight was reduced to quantitative perception of light. Iridectomy was performed with a satisfactory result, and with the ophthalmoscope one could see flaky opacities in the vitreous, with an extensive atrophy of the retina and the optic nerve, while the choroid was normal.

The appearance of retinal changes in eyes of this kind has long been known, but they were believed to be consequent and dependent upon the choroiditis. Thus v. Graefe * says: "We sometimes assume the existence of an opacity of the corpus vitreum, merely because the fundus appears equally blurred." V. Graefe also noticed retinitis as a symptom, but he attributed it to an opacity of the vitreous, on account of the uniformly veiled appearance of the fundus. That changes in the choroid are wanting was also known. V. Graefe says: "Changes in the texture of the choroid appear only very late, for we do not find remnants of the affection after the performance of the iridectomy." But he lays stress upon the "development of the chorio-capillaris, the finely punctate network of which disappears entirely, and the layers of the external vessels are covered with a uniform red." He therefore believes that hyperæmia of the choriocapillaris and the pathological imbibition of the vitreous body must be assigned as the primary cause of the secondary choroiditis. The choriocapillaris, however, as far as we can

* Arch. f. Ophth. I., 2, p. 231.

perceive with the ophthalmoscope, does not participate in the formation of the image of the fundus, and we cannot even see it under the most favorable conditions, *i. e.*, when the epithelial pigment is entirely wanting. It is therefore a fallacy to believe that we can diagnosticate with the ophthalmoscope hyperæmia of the choriocapillaris.

We could perhaps be tempted to explain the impossibility of diagnosticating a choroiditis ophthalmoscopically, by assuming that the disease is situated in the most anterior portions of the choroid, which we cannot reach with the eye. But even if we grant that this invisible choroiditis does exist, we do not concede that retinitis may not independently manifest itself. For the latter is generally situated at the most posterior part of the globe, *i. e.*, at a great distance from that portion of the choroid at which we would like to place the disease. Foerster advances that specific retinitis ought to be correctly called choroiditis, as it is so frequently complicated with opacities of the vitreous.* But does this prove anything besides the fact that opacities of the vitreous may coexist with retinitis?

In chronic iritis, with occlusion of the pupil, bulging of the iris, and diminution of the size and tension of the globe, an ophthalmoscopic examination is commonly impossible, the opacity of the vitreous being too dense to illuminate the fundus. But there are many autopsies of such eyes on record, showing that, in such cases, the hyalitis causes atrophy of the vitreous and detachment of the retina, according to the manner first described by *Hy. Müller*. Previously, the detachment of the retina was considered the result of choroidal exudation, and even to-day the above mechanism of detachment is not thought to be so frequent as it really is. Detachment of the retina is a very common occurrence in eyes which have become phthisical by chronic iritis, perforating corneal ulcers, injuries of the anterior part of the globe and subsequent suppuration, cyclitis, etc., and by the autopsies of such eyes I have convinced myself that the atrophy of the vitreous precedes the subretinal effusion. *Von Arlt*, as far as I am aware, was the first who declared that the complex of symptoms described, after *Beer*, under the name of *ophthalmia*

* Arch. f. Ophth. XX., 1, p. 61.

interna, was mainly choroiditis. *Post-mortems*, however, have since shown that in these cases the changes in the choroid are unimportant compared with those in the vitreous and retina. I myself have examined eyes in which the retina was detached like a funnel and the vitreous absorbed, yet the choroid showed no alterations, not even in its epithelial layer.

The way which leads from the primary iritis to the ultimate blindness is now clearly traced. I will sketch it again. *Acute iritis is frequently accompanied by retinitis or hyalitis, or by both at the same time. After the termination of the iritis the more tenacious intra-ocular complications persist. In the majority of the cases they finally get well too. In some, however, they slowly progress quite independently of the condition of the iris, and deteriorate the vision for months and years after the primary iritis has disappeared. According as retinitis or hyalitis persists, the final issue is atrophy of the retina and optic nerve, or atrophy of the vitreous and detachment of the retina.*

I am far from denying the occurrence of irido-choroiditis in general, be it either isolated or in combination with retinitis or hyalitis; my object in this paper was to restrict the unduly extended domain of irido-choroiditis, and to draw the attention of the profession to irido-retinitis and irido-hyalitis, which are not sufficiently appreciated.

What consequences for the practitioner follow from the above detailed connection? First, he will, in every case of acute iritis, examine the background of the eye, and not declare the disease cured when only the external appearance of the eye has become normal again. We are very apt to explain any deficiency of sight after iritis by changes in the pupillary space, and discharge the patient while he still has retinitis; further we readily consider opacities in the vitreous as an innocent remnant of a preceding choroidal hyperæmia or irritation. For the milder cases of intra-ocular complications, the prolonged care of the eyes which the iritis renders necessary is sufficient; but for the severer cases the inunction treatment is indispensable. Iridectomy has no influence on the course of the retinitis or hyalitis. The erroneous supposition of the presence of opacities of the vitreous in glaucoma has led to the belief that iridectomy is apt to accelerate the re-

sorption of exudations in the vitreous. If we leave glaucoma out of the question, we shall in vain seek a case in which iridectomy has changed the condition of opacities in the vitreous. In cases in which iritis leaves circular or almost circular synechia, the iris remaining in its plane and the pupil permeable to light, iridectomy is, at best, superfluous. Experience has shown me the incorrectness of both suppositions: first, that posterior synechiæ necessarily, or, at least, probably, will destroy sight; and, secondly, that iridectomy can prevent blindness. I have frequently seen a prophylactic iridectomy made, and have made it myself, when, after iritis, circular synechiæ, good vision, and a pervious pupil were left. The operation in some of these cases had no effect on the vision; in others the patients complained, though vision tested with the test types was the same; in others, again, vision had decidedly become worse.

R. P. was under treatment for bilateral specific iritis from Feb. 8 to April 30, 1868. Circular synechiæ, but pervious pupils remained. April 7, S. $\frac{20}{30}$ in both eyes. Right pupil representing a very narrow slit; iridectomy faultless. Three weeks later S. right eye $\frac{20}{100}$, left, $\frac{20}{30}$. We could not explain why the coloboma thus reduced S., but had to acknowledge the fact.*

If circular synechia is followed by iritis and retention of the exudation in the posterior chamber, iridectomy is indispensable and its effect excellent. Circular synechia does not, in itself, necessitate a relapse of iritis, but immensely increases the danger of a subsequent iritis, since it diminishes or almost abolishes the possibility of a spontaneous recovery. An iritis under such conditions may destroy the eye. The tension of the tissue of the iris by the accumulated exudation causes a permanent inflammatory irritation, manifesting itself by severe and persistent pain, and a disturbance of circulation, of which numerous dilated blood-vessels on the surface of the iris bear witness. After the

* After operations for glaucoma, S. sometimes diminishes in an unexplainable degree (See BERLIN, *Klin. Mon. Bl.*, VII., p. 402; MAUTHNER, *ibidem*, p. 403). In a patient with glaucoma simplex and S. $\frac{20}{30}$, who had been operated on without accident, S. was $\frac{20}{100}$ three weeks later; in another patient who, before the operation, could read *Jäger* 3 fluently, S. diminished so much that two weeks after the operation he could read *Jäger* 16 only.

iridectomy the pain and blood-vessels disappear, and the iritis can now be readily cured by the ordinary treatment. In as far as a chronic course of iritis leads to sacculation of exudation behind the iris, iridectomy will have a beneficial effect. It will obviate disorganization in the iris, participation of the morbid action in the ciliary body, and, to a certain degree at least, formation of cataract in the lens. But never have I noticed a direct influence of the iridectomy on the intra-ocular complications, nor the refilling of a globe that once had become atrophic, nor an improvement of the vision which could not satisfactorily be accounted for by the establishment of a new path for the rays of light, and the removal of a mechanical irritation which rendered the iris predisposed to renewed inflammation.

ON THE QUESTION OF THE DECUSSATION OF THE OPTIC NERVES.

By J. HIRSCHBERG, of Berlin.

(Translated by Dr. F. A. Munson, of Albany, N. Y.)

(With Illustrations.)

Whereas, the question of the hemiopic defects in the field of vision has latterly been somewhat confused by the arguments for a total decussation of the optic fibres in the chiasm—although many authors, conspicuously *L. Mauthner* * and *H. Knapp*,† as well as the writer of these lines, have adhered to the semidecussation theory of *J. Müller* and *A. v. Graefe*—the recent experiments of *Gudden* (Arch. f. Ophth., xx.), have given a most satisfactory vindication of the clearness of the older view.

I have myself recently observed a case of defined symmetrical right-sided defect in the visual field of both eyes, with a nearly normal acuity of vision, and a normal ophthalmoscopic picture, accompanied by aphasia and hemiplegia of the right side; where the autopsy revealed a tumor as large as an apple in the left frontal lobe, implicating the left optic tract. (Virchow's Arch., lxv.)

I desire to communicate another case of right-sided hemiopia, in order to add two short observations upon the subject.

Max B., aged 25, came to my clinic on the 5th of August, 1874. Two years before he had acquired an ulcer ad penem, and had been subjected to the inunction cure; later, when secondary ulcers of the throat made their appearance, he was treated with the iodide of potassium. In January, 1875, he was again subjected to the inunction treatment on account of a numbness and pain in the feet. Last April his sight became suddenly affected, and has since remained unchanged; reading is very difficult, because he is unable to see the final syllable of a word and the

* Zeitschrift f. prakt. Heibkunde, 1872.

† Brown-Sequard's Arch., Feb., 1873.

rest of the line. Numbness of the feet has again appeared and his gait has become unsteady.

Right E. Sn. XX at 15′, Sn. 2 from 6—13″.
Left E. Sn. XX at 15′, Sn. 2 from 5—11″.

The patient asserts that his vision has been decidedly better than at present. The right half of each visual field is so completely destroyed, that even quantitative perception of light no longer exists in them. The line of division is symmetrical on both sides, and runs vertically from above downward, and is a trifle (about 3°) to the right of the point of fixation, as the subjoined figures distinctly represent. There is no

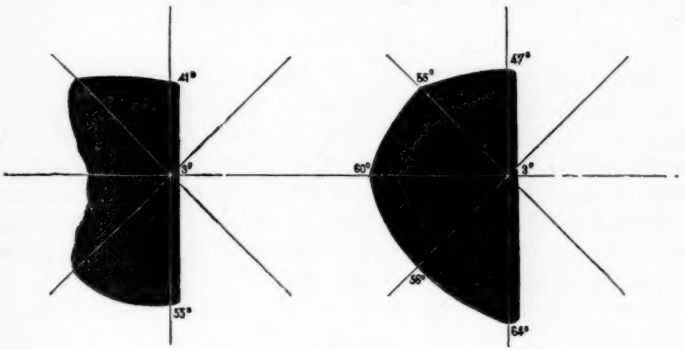

FIG. 1.

intermediary zone with diminished visual power, and the perception of colors in the normal field is perfect.

The fundus of the left eye is normal, the papilla optica rosy, but the physiological excavation is somewhat whitish. The latter condition is rather more pronounced in the right eye, where the art. med. retinæ, with strong amplification (both in the upright image and with +3 in the inverted), appears as a scarcely perceptible fine red line, while the same vessel in the left eye, with equal enlargement, appears as a small red streak.

The sense of smell is preserved on both sides, but is more acute on the right than on the left side.

The motor power of the left lower extremity is decidedly less than normal, although no pronounced paralysis is present. Forced extension he finds difficult, so that when seated, although able to remove his boot by hand from his right foot, he cannot draw off the left boot in the same manner, but is obliged to use a boot-jack. He can move around on his

right leg, but not on his left; sensation seems to be normal in both extremities.

If we transfer, by means of central projection from a fixed point, the visual field of such a typical case (and the representation of the visual field of the first-mentioned case was exactly as in this instance) upon a plane surface, we shall notice, first, that the line of demarcation is *vertical* and *symmetrical* throughout, not irregular and jagged, as in the cases of *Förster* and *Cohn*, which, as *Mauthner* has already directed attention to, cannot be regarded as in part typical. And farther, there is, adjoining the defective side, such a zone of impaired function of a few degrees. *Wollaston* found 3°; in the first case I observed nearly 5°; in the second, with repeated and exact examination, about 3°; so that there is perhaps a retinal zone of 6°, which would be halved by a vertical line drawn through the point of fixation, in each eye, supplied in common from both optic tracts. It is manifest that the nerve fibres of the two tracts must here interfere,* *i. e.*, be interwoven with one another before reaching their terminus. The result is that there must always be a reduction of the central acuity of vision whenever there is complete paralysis of one tract. It may very well be imagined that there is a kind of interlacing of fibres, so that each eye possesses a visual power greater than ½, as tested with *Suellen's* types.

If we really examine physiologically by means of a lattice work the minimum of the angle of distinction, it will be found of almost double its normal size, *i. e.*, S. ½. The ophthalmoscopic conditions in my case correspond accurately with the supposition which *Mauthner* has made. (Oesterr. Zeitsch f. prakt. Heilkunde, 1872.) The right papilla, which receives the fasciculus cruciatus of the paralyzed left tract, exhibited the picture of partial atrophy; the latter always first makes its appearance on the macula half of the disk.

* Vergl. MICHEL, in the Jubilee volume of LUDWIG's Arbeiten.

HEMIOPIA AND OPTIC DECUSSATION.

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(Translated by Dr. F. A. Munson, of Albany, N. Y.)

(With five Illustrations.)

THE decussation of the nerve fibres in the chiasm has formed a subject of active discussion for some time past between the believers of a partial and of a total crossing. *Biesiadecki*, *Mandelstamm*, *Michel*, and *Pawlowsky* believe they have demonstrated histologically and by pathological investigation a complete crossing of the nerve fibres; *Mandelstamm* likewise endeavored to bring clinical observations (incited especially by some cases of so-called nasal hemiopia) into harmony with the anatomical conditions, and constructed a theory in order to explain all forms of hemiopia upon the supposition of a total crossing, after having previously disposed of the generally received views of *J. Müller's* semidecussation as an impossibility. *Gudden* soon afterward published the results of his experiments upon rabbits and dogs, from which he declares that a total crossing of the fibres in the chiasm is not apparent in man and those mammals whose optic axes are directed forward, but that in them a partial decussation most undoubtedly takes place, a view confirmed by *M. Reich*. *Mauthner* and *Schön* had previously criticised and disputed the theory and manner upon which *Mandelstamm* sought to interpret the pathological appearances of hemiopia.

As a patient recently presented himself to me with right-sided hemiopia, I resolved to examine all clinical material, so far as accessible, in order, if possible, by comparison of similar cases, to ascertain which of the views concerning the relation of the nerve fibres in the chiasm could be supported by observations

upon the sick bed. I may be permitted to communicate the results of my work in the following lines:

By hemiopia we generally understand a symmetrical defect in the visual field of both eyes, caused by some intracranial disease; the several forms of hemiopia being distinguished according to the direction of these defective parts in the field.

a and *b*, bilateral or equilateral hemiopia, in which either the right or the left half of the visual field in both eyes is deficient —hence right-sided or left-sided hemiopia. The defects are very frequently completely symmetrical, the unaffected halves constituting a normal visual field, or nearly such. In the following forms, on the contrary, symmetry is rarely observed, the visual fields of both eyes being often very dissimilar.

c and *d*, upward and downward hemiopia, with defective fields in corresponding directions.

e and *f*, nasal and temporal hemiopia, in the former of which the medial, and in the latter the lateral portions of the field are obscured.

The peculiarities of some varieties require separate consideration, which we shall commence by first considering *temporal hemiopia*—that form in which the defective parts of the field lie upon the temporal sides of each eye, corresponding to portions of the retina upon the nasal sides, the nerve fibres of which have either become incapable of conduction from cerebral causes, or lead to ganglion cells whose functions have been lost. It is necessary to emphasize the intracranial cause, because intraocular diseases may create defects in the field, and induce conditions closely resembling the various forms of hemiopia from cerebral causes. Such diseases, for example, as atrophy of the optic nerve, glaucoma, neuritis, retinitis pigmentosa, etc.

I am enabled to communicate in the accompanying drawings a few such false hemiopic defects of the visual field. Fig. 2 represents the right and left fields in a lady patient aged 30 years, who had suffered for ten years from choroiditis in both eyes. Her central acuity of vision gradually diminished, so that in six months S.= $^{1}/_{0}$ in either eye. The sensitiveness toward light, as tested by *Förster's* photometer, scarcely deviated from the normal. The ophthalmoscopic picture was one of choroiditis with

progressive atrophy of the optic nerve; the papillæ were of a greenish color without a trace of red, and the vessels were ex-

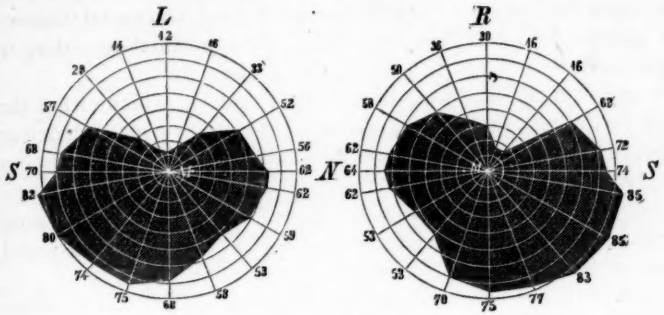

FIG. 2.

tremely fine. At present S=$\frac{5}{200}$, and the periphery of the field remains the same, exhibiting the finest picture of *superior or upward hemiopia*, whose outlines very nearly correspond with *Mauthner's** case, represented in Fig. 6.

Fig. 3 illustrates *temporal hemiopia* with genuine atrophy of

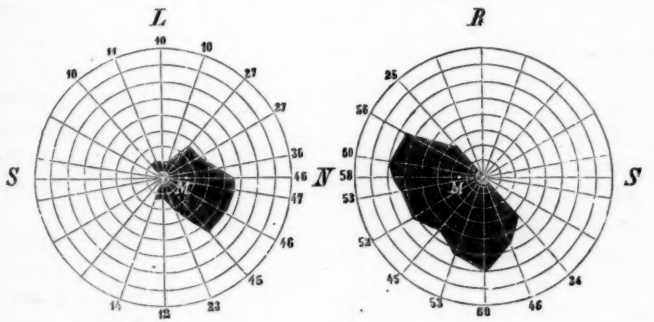

FIG. 3.

the nerve in a man 56 years of age (S=$\frac{20}{40}$ in both eyes), whose power of vision has progressively diminished for two years past.

* *Mauthner*, Oesterr. Zeitschrift f. prakt. Heilk. XVIII, Jahrg., Nr. 24, 1872.

The outlines correspond nearly with Figs. 14 and 15 of temporal hemiopic fields drawn by *Schön*.* Fig. 4 gives the visual field of the right eye of a man affected with simple glaucoma—the left eye being cataractous from the same disease—with a central acuity of vision $=\frac{10}{40}$, and represents a form of contraction not infrequently met with in glaucoma, and usually appearing in a remarkably symmetrical manner on both sides, resembling the visual field of nasal hemiopia.

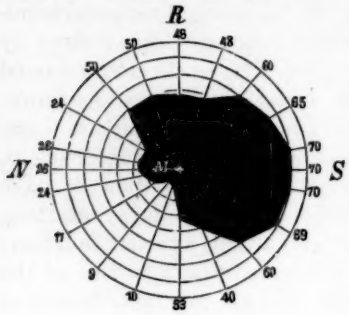

FIG. 4.

The visual fields of Figs. 2, 3, 4, 5, and 6 are taken from the centre of the blind spot. The fixation point M, corresponding to the centre of the macula lutea, is marked by a fine white dot. The number of degrees over which the visual field extends in any given meridian is accurately recorded at the end of the meridian.

Now, if cerebral disease supervenes in such a case, before being seen by the physician, or if some one or another symptom points with a degree of probability to an intracranial process, the examiner may be easily led into error, and associate the anomalies of the peripherical visual field with existing or apparent disease of the brain; if we attempt to investigate the history it will not be difficult, as every practical physician well knows, to obtain almost any history from one patient, according to the manner in which the questions are asked; even although the history is voluntarily given, it is, even with intelligent people, often impossible to ascertain which were the leading symptoms—the cerebral or ocular. Such mistakes are more apt to creep in when the ophthalmoscopic picture is the same as that of hemiopia; for instance—atroph. nerv. opt., neuritis, choked papilla. These facts certainly challenge the greatest care in the diagnosis of this disease, since the clinical observations and their significations should not create complications and fruitless hypotheses, instead

* *Schön*, Die Lehre vom Gesichtsfelde und seinen Anomalien, 1874, Tafel. E., Figs. 14 und 15.

of clearness and security in the solution of this most interesting and important question.

I find fourteen cases reported in the literature of temporal hemiopia: six cases collected by *Mauthner*,* four by *Schön*,† three by *Mooren*,‡ and one by *del Monte*.§ According to the above-named observers, the clinical course of the disease assumes various forms. In some cases (*Müller*, *Sämisch*, *Löwegren*), the disease commenced with a gradual reduction of visual power, progressing to complete blindness. The amaurosis lasts a short time, or, as in one case cited by *Sämisch*, it continued nineteen days; returning sensitiveness to light then appears and attains a certain indefinite height, but at the same time it is observed that a portion of the retina is not restored to functional activity, the inner section of the retina on both sides remaining insensitive. Cerebral symptoms may be entirely absent, or may accompany or follow the functional changes in the visual apparatus. *Von Graefe*, *Mooren*, and *Schön* observed defects in the visual field simultaneously with the reduction of central vision; *Wecker's* case is characterized by the appearance of the disease at certain times. If the limitation of the visual field is once defined, the further course may vary much. The functionless fibres gradually resume their activity, restitution ad integrum results (as in *Graefe's* case), when the exciting cause either entirely disappears or becomes in a manner so reduced that the sight is no longer affected. To be sure, in the latter case, the primary condition may be again invoked by some cause (as in *Wecker's* case), even if the real cause reacquires its injurious powers or is renewed by any local disposition.

Causes sometimes arise, unfavorable for vision but otherwise for life, which even progress happily for a while, because the contraction of the field as well as the decrease of central vision keeps for a long time within the limits indicated by the exciting cause. *Schön* relates such a case which he had observed for fourteen years, and which was very remarkable on account of the fluctuations of the visual field. The patient saw a short time before

* *Mauthner*, Oesterr. Zeitschr. f. praktische Heilk., 1872, Nr. 21, 22.

† *Schön*, Die Lehre vom Gesichtsfelde und seinen Anomalien, 1874, p. 70.

‡ *Mooren*, Ophthalmiatrische Beobachtungen, 1867, p. 304.

§ *Schön*, l. c., p. 72.

his presentation only the right half of fixed objects with his left eye; after treatment in Hamburg this symptom disappeared, only, however, soon to reappear in both eyes, so that but half of an object was seen with monocular vision, whereas the entire object became visible with binocular vision, the paralysis corresponding to the inner portions of the retina. This condition remained unchanged for a year, and the visual field was sharply defined. Transitory improvement was produced by repeated treatment, but after two years the outlines of the left field were no longer defined, and objects were seen indistinctly in their outer halves. The visual field of the right eye is distinctly enlarged, being only defective at the upper edge, which condition has not materially changed since 1863. A second case observed by *Schön* likewise remained a year unchanged—the disease having been definitely arrested or temporarily inactive; perhaps only, at a future time, by unknown causes, to renew its destructive action.

The worst form progresses unceasingly with destruction of central vision, and with darkening of the peripherical field, either accompanied from the start by pronounced symptoms of cerebral disease, or these symptoms occur later in the course—a fatal termination following the occurrence of blindness. (*Sämisch, Müller, Mooren.*)

The behavior of the visual field, its subsequent changes, and the cerebral symptoms, in most of the cases quoted, leave no doubt as to the cause of this rare disease. They point directly to a compression of those nerve fibres supplying the inner portion of the retina, which effect may be produced by any new growth or inflammatory product. If we regard a tumor as the cause of the affection under consideration—which *Mackenzie, v. Graefe, Löwegren,* and *Mooren* considered to be most probable in their cases, and which *Schön* believed to be the excitant in cases Nos. 27 and 28 reported by him—a cause likewise confirmed by autopsy in the cases of *Sämisch* and *Müller*—we shall find it easy to explain all the various manifestations in the course of the disease. The sarcomatous growths found upon section in the last two cases were situated in the anterior angle of the chiasm between the optic nerves, and led by increased growth to complete amaurosis. Should a reduction in size of the neoplasm take place in some way, as, for instance, by a decrease in

its vascular supply, so that the nerve fibres are relieved—or should it happen that after the first attack, possibly by the commencement of a more rapid growth in the tumor, the temporarily-incapacitated nerve fibres should later adapt themselves to the pressure sufficiently for them to renew their activity, the visual power would improve, until finally a fatal result ensues from increased growth of the neoplasm. In a similar manner I would analyze case No. 27 of *Schön:* the neoplasm, being situated in the outer angle of the chiasm, primarily pressed upon the left optic nerve, from which the defect in the left visual field resulted. By a derivative treatment or post hoc the size of the growth diminished, and the impairment of vision disappeared for a time, while with a renewal of growth not only the left but also the right nerve became involved, so that a defect arose in the visual fields of both eyes. The transitory improvement is thus explained: A regressive metamorphosis now probably commenced in the neoplasm, causing a contraction or shrinking, with resulting improvement of vision; *v. Graefe* explained the case observed by him upon the supposition of a basilar pachymengitis; *Wecker's* case, in which there were periodic defects in the field, may be similarly explained; there must have been several inflammatory relapses. A neoplasm of changing volume may likewise induce temporal hemiopia with similar manifestations. As relates to *the form of the field*, the cases cited show that there is frequently a zone inserted between the normal and affected parts of the retina, which is sensitive to a bright illumination, but with a faint illumination the abolition of function shows that the nerve fibres supplying these parts have suffered from the pressure. It may also happen that there is a defined transitionary border; thus the nerve axis cylinders become totally affected up to a certain point, which, subsequently, under diminished pressure, forms the transition from the perceptive to the blind portions, or, by an adaptation to the existing condition, the function is partially restored. *Müller* and *Löwegren* report that the defect is sharply defined from the normal functional portions of the retina. I imagine that during the first attack which led to amaurosis, a number of fibres directly exposed

to the cause of pressure were permanently incapacitated, whereas the adjoining and more remote fibres or bundles of fibres, being the most compromised, lost their functions, but only at times, while under the influence of compression. As the pressure now diminishes with the decrease in volume of the neoplasm, these fibres reacquire their functional activity, while those no longer serviceable in the visual act, thus being sharply defined from the former, form the intermediate transition from the perceptive to the blind halves of the retina. This hypothesis is supported in every particular by *Löwegren's* case, in which the sharp line of separation is only pronounced in the right eye, which also manifests the greatest defect in the visual field; in the left eye the transition from the light to the dark portions is effected by such a zone, and the entire defect is smaller. The cause of pressure has here principally altered the right optic nerve, destroyed the nearest lying fibres, but only temporarily paralyzed the remaining fibres, so that they again become capable of functional activity upon a remission of the pressure. The ophthalmoscope revealed, even in this eye, with a well-defined defect, a commencing atrophy.

The defects in the visual fields of the two eyes, as compared with one another, are, as might be expected, often similar in size and form, although sometimes the preserved portions of one field surpass those of the other; each defect may be of varying size. *Schön** delineated in Table E, Nos. 24 and 25, the fields of temporal hemiopia, in which in one case the upper outer quadrant failed, while in the other only a very small part of the upper inner quadrant remained perceptive. Unfortunately, the other cases were not examined by the perimeter.

The ophthalmoscopic picture, according to the statements of *Müller* and *Sämisch*, as well as of *v. Graefe* and *Wecker*, appeared to be negative each time; *Schön* likewise makes no mention of pathological changes in cases Nos. 27 and 28; in cases Nos. 29 and 30, however, the appearances are those of atrophy of the optic nerve, complicated with glaucoma in the right eye of the second case.

These conditions, together with the representations of the

* Schön, l. c.

fields in these two cases, appear to me incorrect, as they should more properly be arranged under that form which I have mentioned in introducing this variety of hemiopia. *Möoren* mentions one case of choked disk as the ophthalmoscopic characteristic. It is very remarkable that only in relatively few cases, in spite of the long existence of the disease, changes in the ophthalmoscopic pictures are seen, and that even *Müller* and *Sämisch* obtained negative results, although the tumor had attained a considerable size, and was apparently favorably situated for the production of neuritis and choked papilla. It is just as remarkable that in other cases, where the impairment in function of the nerve fibres has continued a long time, from which we may assume their destruction to have occurred, that no trace of atrophy could be detected with the ophthalmoscope. This occurrence of atrophy is rather to be expected, because there is a destruction of those nerve fibres supplying the inner half of the retina, with which atrophic process the inner half of the papilla must appear pale; and because the outer half in most eyes reflects the most white light, and hence appears normally pale, it follows that the whole papilla will appear blanched when the inner half is pale, and thus offer a complete ophthalmoscopic picture.

Defects in the inner portions of the field from impairment of function in the *outer* parts of the retina are known as *nasal hemiopia*. This form, so interesting in itself, deserves an especially extended notice, because it furnishes the cause which lays open to question the almost generally received views of anatomists and ophthalmologists as to the partial crossing of the optic fibres in the chiasm. *V. Graefe** declared himself incapable of giving an anatomical explanation of nasal hemiopia from cerebral disease. *Mandelstamm*,† who is the principal defender of the theory of total decussation, sought an explanation of hemiopia accompanying paralysis of the outer half of the retina in a total instead of a partial crossing of the fibres, and inaugurated a peculiar theory to explain all forms of hemiopia. In his paper upon the

* *V. Graefe*, Arch. f. Ophth., II., 2, 1856, p. 288.

† *Mandelstamm*, Arch. f. Ophth., XIX. 2, 1873, p. 39.

decussation of the optic nerve and hemiopia, he states the facts which lead him to that supposition; he says: "Observations upon the sick bed have tended for a long time to convince me that the half crossing of the nerve fibres in the chiasm, the existence of which is admitted by nearly all ophthalmologists and anatomists (the so-called semidecussation of *J. Müller*), does not at all correspond to clinical experience; for instance, it proves insufficient as concerns hemiopia with a relatively well-preserved internal and an amaurotic external half of the retina, or with limitation of the field to the nasal side in both eyes, as quite frequently occurs in neuro-retinitis of central origin, the result of inflammatory processes or neoplasms in the brain. I have, for my own part, observed for a long time within the last year four cases inexplainable by *Müller's* theory." The results of anatomical research are given by *Mandelstamm* in the concluding words of his paper: "I close in the hope that further observations at the sick bed and *post-mortem* table will confirm the total crossing of the nerve fibres in the chiasm, inasmuch as no facts as yet contradict it, but anatomical investigations, physiological experiments, and clinical experience harmonize to confirm it."

*Michel** arrived at the same conclusions from his anatomical investigations, previous to which *Biesiadecki*† had made the same statement upon the basis of histological examinations. The latter closes his communication with the following lines: "My experiments lead me to agree with those who assert that a complete crossing of the nerve fibres takes place in the chiasm of all vertebrates, including man." There are but ten cases on record of nasal hemiopia. *V. Graefe*‡ reported that he had seen one such case; no particulars were given. *Mandelstamm*§ reported two cases from the Ophthalmic Institute in Wiesbaden, with strongly-marked cerebral symptoms, at one time with slight, and another with considerably reduced central acuity of vision, contraction of the peripherical field toward the nose on both

* *Michel*, Arch. f. Ophth., XIX. 2, 1873, p. 59.

† *Biesiadecki*, Sitzungsb. d. k. Akademie der Wissenschaften: Ueber das Chiasma nerv. opti., der Menschen u. der Thiere, 1860, XLII. B., p. 87.

‡ L. c.

§ *Mandelstamm*, l. c., p. 39.

sides, without being defined, and with pronounced choking of the disk; besides, he mentions two other cases, as well as cites *Schüle's** case: "The Results of Autopsies in Mental Diseases. Leipsig, 1874, p. 128, case 17. *G. Freund:* Progressive imbecility with paralysis. The disease began with amblyopia in the right eye, atrophy of the papilla, with blue discoloration and marked reduction of eccentric vision; later, atrophy commenced in the left papilla, with a similar course and changes in the arterial vessels. Autopsy: the ventricles much dilated; the infundibulum and both nerves distinctly atrophied and of a grayish color. *Wegner* and *Schmidt*† report a similar case, which is of more importance, on account of the patient's previous history being added to the *post-mortem* history. *Bernhardt*‡ refers to a case of nasal hemiopia observed by *Knapp:* the patient, a man 60 years of age, suffered from headache, dizziness, vomiting, and limitation of the visual field; examination revealed double-sided neuro-retinitis, particularly marked in the right eye, with diminished acuity of vision. Movements of the hand were only visible in the outer half of the field with either eye; the line of separation between the perceptive and non-perceptive portions was, in the right eye, vertical, but in the left ran somewhat obliquely from above inward, downward, and outward. After death the brain was found healthy, but anæmic, the basilar arteries were highly atheromatous, rigid and unyielding, especially the anterior and posterior central, and the anterior and posterior communicating arteries, which pressed upon the outer sides of the chiasm like stiff cords. The chiasm and optic nerves were found softened and atrophied. *Mooren*§ relates two cases of nasal hemiopia; one referable to atrophy of the optic nerves, the other, of only two days' duration, was wholly obscure.

The prognosis, as regards vision, is in all cases extremely unfavorable, for the hemiopic darkening of the field progresses in a relatively short time to complete amaurosis. *Wegner's, Schmidt's,*

* *Mandelstamm*, Klinische Mon.—Bl. f. Augenhlkde., 1875, p. 951.

† *Wegner* und *Schmidt*, Arch. f. Ophth., XV. 3, p. 253.

‡ Centralblatt, f. medic. Wissenschaft, 1874, No. 3.

§ Ophthalmiatrische Beobachtungen, 1867, p. 304.

and *Knapp's* cases all terminated fatally. The transition from the perceptive to the blind portions of the retina was always a gradual one and without a sharply-defined border. The ophthalmoscopic picture was ever a positive one, neuro-retinitis or a high degree of choked papilla being noted in each case. The hemiopic disease was accompanied by pronounced symptoms of cerebral disease in every instance. The questions now present themselves: What are the causes of nasal hemiopia? What relationship do the defects in the visual field bear to the cerebral disease on the one hand and to the ophthalmoscopic conditions on the other?

*Mandelstamm** assumed as the cause in his cases the presence of tumors having their seat in the median line at the base of the cranium or higher up in the brain, and asserted that, "no matter where the morbid process may have its seat in these and similar cases, it never could, in case semidecussation existed as a matter of fact, destroy simply the function of those nerve bundles of the optic tract which were given to the outer halves of the retinæ." He further demonstrated by a diagram the manner in which each form of hemiopia could be intelligently comprehended by the theory of total crossing. Especially for nasal hemiopia should the morbid process have its seat in the posterior angle of the chiasm, between the latter and the pons, somewhere on the base or higher in the brain itself. The case of *Wegner* and *Schmidt* has been particularly used as an illustration of total crossing. "The tumor found upon section sprang from the median line of the brain; the infundibulum, fornix, and septum pellucidum, —parts which press upon the posterior angle of the chiasm, or at least, when exercising pressure upon the chiasm, chiefly act upon its posterior angle—were above all affected; in consequence of which the nerve fibres given to the outer halves of the retinæ were functionally incapacitated, and nasal hemiopia was the result." *Knapp*, an adherent of the semidecussation theory, explained the hemiopia in his case as due to a high degree of arterial atheroma, and believed the fibres of the outer angle of the chiasm, the fasciculi laterales, to be incapacitated from function

* *Mandelstamm*, Arch. f. Ophth., 1873, XIX. 2, p. 40.

by the pressure of the rigid and unyielding vessels, thus giving rise to nasal hemiopia. To *Mandelstamm*,* on the contrary, this case explained itself in accordance with the conditions of a total crossing, the optic fibres to the outer sides of the chiasm being involved to a greater extent than the corresponding tract fibres. *Mauthner*† believed this uncommonly rare case might be attributed to the development of symmetrical tumors, or of one situated in the median line on the base of the cranium, somewhere between the origin of optic nerves and the foramen opticum, which, developing more rapidly or to a greater extent at its sides, first involved the outer and then the inner fibres; or, finally, it might also be due to the development of a medial cerebral tumor, in case the medial origin of the uncrossed fibres had its seat behind that of the crossed bundles. He further adds: "It is possible that the cerebral tumor only immediately involved or caused the double-sided neuritis, and that the nasal hemiopia, which was observed at a certain stage of the disease, had its origin as the result of a definite anatomical condition (greater rigidity) of the lamina cribrosa at that point where the uncrossed bundles of fibres penetrate; the latter thus became earlier functionally incapacitated by the swelling of the unyielding tissues than the fibres of the fasciculus cruciatus. *Schön*‡ entertains similar views.

Permit me to add an observation in this connection. The correctness of *Mandelstamm's* views, as to the presence of tumors in the three cases above cited, is certainly not to be questioned, and less so since *Wegner* and *Schmidt* were convinced of the same upon the autopsy table. Only the direct connection of the tumor with the limitation of the visual field appears to me rather doubtful. *Mandelstamm* and *Michel* believe that pressure may be exercised upon the posterior angle of the chiasm, by enlargement or displacement of the infundibulum (as really occurred in the case of *Wegner* and *Schmidt*), sufficient to incapacitate those fibres which by the theory of total decussation supply the outer halves of the retinæ. *Mandelstamm* adds some *post-mortem* results to the observations upon the acuity of vision and the con-

* *Mandelstamm*, Klinische Mon.-Bl. f. Augenhlkde., XIII., Jahrg., 1875, p. 95.

† *Mauthner*, Oesterr. Zeitschrift f. prakt. Heilkunde, 1872, VIII., Jahrg., Nr., 23.

‡ *Schön*, Die Lehre vom Gesichtsfelde und seinen Anomalien, 1874, p. 74.

traction of the visual field; he says: "The optic nerves and tracts, together with the other cranial nerves, were microscopically in a normal condition. The infundibulum was enlarged and displaced, being transparent, and pressed by lateral pressure into the shape of a vesicle." From which it is to be observed that the pressure induced no trace of flattening or stretching in the optic tracts or nerves. The published microscopical data of *Wegner* and *Schmidt* appear to me of not a little importance in this connection: they state that "nothing abnormal could be found by microscopical examination in the orbital course of the optic nerve;" and, on page 261, that "half of the left eye, removed and hardened in *Müller's* fluid, revealed the following microscopical conditions:

"The optic nerve upon accurate measurement was found atrophied; its diameter at a distance of $\frac{1}{2}$ cm. from the eye being 3 mm., and in a direction at right angles to this $2\frac{3}{4}$ mm. The nerve sheath was normal, as was also the interstitial connective tissue between the nerve bundles. On the contrary, a very remarkable increase of the interfibrillar connective substance showed itself, partly of a finely granular and partly of a finely fibrous form, which everywhere pressed apart the nerve fibres from each other; only a few of the latter were of normal diameter, the greater number being atrophic, mostly to a high degree." Upon page 262: "the right eye presented similar conditions, except that no points of atrophy could be pointed out in the nerve in sections taken up to about 3 cm. distance from the bulbus."

Now, when we consider that we have here to deal with a gliosarcoma of very rapid growth (beginning in the winter of 1868, and reaching a fatal termination June 29, 1869, about eight months); that, Jan. 8th, there was already noticed decided reduction of the central acuity of vision on both sides, with retinitis and a high degree of choked papilla, and that it showed very little change before the month of May—the amblyopia, however, having in the meantime made frightful progress without producing contraction of the peripherical field, notwithstanding the lapse of six months since the commencement of the disease—when we further consider that according to the section the tumor sprang from the septum pellucidum, fornix, and the posterior lower portions of the

brain, which stand in most intimate connection with the third ventricle and the infundibulum, and whose dilatation and curvature could hence be easily affected (to be sure, it was only *somewhat* enlarged), and that notwithstanding neither a trace of pressure was to be found on the tractus or nerv. opt., it requires a strong belief to assume that by direct pressure upon the posterior angle of the chiasm of those parts of which *Michel* and *Mandelstamm* speak (infundibulum, fornix, and septum pellucidum), the incapacity of the fibres there placed and consequent defect in the visual field to the nasal side should have arisen.

This view of *Mandelstamm's* must be completely discarded when the microscopical conditions are considered. "The tractus and nerv. opt. in the cranium were in a normal state; the left optic nerve became atrophied at the distance of 1½ cm. from the eye, only a small proportion of the nerve fibres at this spot were of normal diameter, the greater part being atrophic to a high degree. The ganglionic layer of the retina was atrophied throughout." Hence there was here an atrophic process in a transitory stage from the normal state to one of great atrophy in the nerve near the eye, sufficient to explain the impairment of vision. The central affection gave rise to retinitis and choked papilla, leading to a regressive metamorphosis and atrophy, which progressed centripetally. These relations are more definite in the right eye, in which the process was less advanced; there was retinitis with choked papilla and atrophy of the ganglionic layer—indeed, changes quite similar to those in the left eye—but the atrophic process was not yet established in the optic nerve, which was completely normal in every respect. This difference in the pathologico-anatomical relations of the two eyes and nerves also corresponded to their functional variations. The right eye always possessed a much better acuity of vision, and most probably the defect in its field, measured by the perimeter, was also less.

That this correlation between the local disease of the retina and the optic nerve on the one hand, and the impairment of vision on the other, really takes place, it seems to me is confirmed by the second case of *Wegner* and *Schmidt*, described with the above, which may be worth considering. It relates to a girl

fifteen years of age, who had latterly (the report was made on the 22d April, 1869) suffered from occasional headache and vomiting, but was otherwise healthy. She complained of a reduction of sight, which took place suddenly in January. The examination of the urine up to this time had revealed no albumen, yet later it was found in varying quantities. The ophthalmoscopic picture was one of neuro-retinitis, in which the retinal changes nearly corresponded with those of Bright's Disease. Both optic papillæ were somewhat swollen. S about ^{11}, both visual fields normal. The acuity of vision gradually diminished, as noted on May 9th; patient read with the left eye only Jäger No. 12, right, Jäger No. 7, with difficulty. May 10th, right No. 14, left No. 17. The ophthalmoscope revealed no essential changes. Finally, on July 1st she no longer perceived the letters of Jäger No. 24, with the left eye, and with the right only single letters of Jäger No. 18; at this time a defect in the visual field showed itself in the right eye to the upper and outer side, and in the left eye to the lower and inner side. An ophthalmoscopic examination revealed: "The margins of the right papilla very indistinct, the partially interrupted blood-vessels appeared less strongly filled, and with their margins ill-defined against the surroundings. White plaques had already developed in some spots near the papilla. The left optic papilla was even less distinctly visible, and the ends of the central vessels disappeared beneath a grayish-red exudation, but again became distinct external to the swollen papilla; the retina was covered with white patches, hemorrhages, etc." *Post-mortem* revealed the following: no foci of disease in the brain, corp. quadd., tract., and optic nerves, neither any abnormity whatsoever of the latter, either in their intracranial or orbital course; but there was pronounced swelling of both optic papillæ. Microscopic examination showed the diameter of the nerve to be normal, and its component fibres completely intact; the retina encircling the papilla was thickened in a zone of 1¾ mm. in width, when it suddenly assumed its normal thickness. At the point where this sudden change occurred transition began; the granular layer exhibited a very intense, uniform, fatty metamorphosis, extending into the periphery, and losing itself gradually toward the æquator bulbi. In the neighborhood of the spots of fatty

degeneration the nerve fibres and ganglionic cells showed the well-known changes of sclerosis, which were, however, not uniform, for normal elements were always to be found between the diseased spots. Similar conditions were found in the right eye.

If disease of the brain were the cause of the visual disturbances, the defect in the field would without doubt be placed to its account; but there is no such correlation in this case, and the cause of the impairment of vision must be sought for in the changes discovered in the retinal elements; and, corresponding to the defect in the visual field, the greatest impairment must have occurred in one eye downward and inward and in the other upward and outward. But why limitation of the visual field should have happened to the nasal side in the first case it is certainly difficult to explain; however, as already observed by *Mauthner*, l. c., the cause of the early interruption of function in those nerve fibres supplying the outer halves of the retinæ may be found in the anatomical structure of the lamina cribrosa. The two remaining cases quoted by *Mandelstamm* are to be explained in a similar manner; they concern hemiopia only in the sense that the outer halves of the retinæ have lost their activity, really brought about by a local cause not lying external to the bulbus.

Incited by the case described by *Knapp, I made a series of perimetric examinations of elderly people of from seventy to eighty years of age, by which I convinced myself that the visual field did not in a single instance show any contraction, but corresponded in extent completely with that of the healthy eye.*

Now, when one considers that a high degree of arterial atheroma may be found in various parts of the body during life, in the majority of these elderly people, and that they constantly have good sight and do not complain of visual troubles, and that, upon accurate measurement of the central acuity of vision and the peripherical field, neither a reduction of the former—disproportionate to the eye—nor a contraction of the latter could be found, while *post-mortems* of such aged people very commonly reveal a high degree of atheromatous hardening of the brain, so much indeed that the optic nerve at the point of contact embraces nearly one-third of the arterial tube, then perhaps a doubt may be raised whether in *Knapp's* case the hemiopia was really dependent upon the

changes found in the cerebral arteries. An accurate microscopical examination of the chiasm, optic nerve, and eye in similar cases would serve to settle the cause of the impairment of vision with some certainty.

From these considerations I draw the conclusion that cerebral disease (tumor, inflam. processes) may produce a neuro-retinitis and choked papilla, and that the latter in its course may cause the impairment of vision; or local disease of the eye alone, without the immediate link of cerebral disease, may directly produce the difficulty, but that this is, however, never brought about by simple pressure upon the posterior angle of the chiasm.

A third form of limitation of the visual field, of cerebral origin, is known as *equilateral* or *bilateral hemiopia*, in which those nerve fibres supplying both right halves of the retinæ are incapacitated, thus producing defects in the left halves of the field —left-sided hemiopia—or the fibres given to the left halves of the retinæ may be affected, whereby defects in the right halves of the fields arise—right-sided hemiopia. The causes of this affection are more numerous than those of the preceding forms. To those cases already enumerated by *Schön** I would add still another of *Illing*.† The patient was a man who became amaurotic in consequence of poisoning by coal gas; in the course of the following day he could again perceive large objects, but indistinctly, and as if through a thick fog, which disappeared in the course of three days. Examination revealed in the right eye M $\frac{1}{4}$, left, M $\frac{1}{8}$; central vision: right, normal; left, reduced; papillæ, normal; annular atrophy of both sides, somewhat more pronounced on the right. In the left eye there was a yellow patch, near the macula lutea, of more than the width of the papilla, which was bordered and dotted with pigment. This was the cause of the reduction of vision in the left eye. Three weeks later the patient noticed that he could not perceive objects situated to the outer side of the right eye; there were no appearances of paralysis. Drawings of the visual field are added to the report. *Zagorsky*‡ reported a case of left-sided hemiopia and

* *Schön*, l. c.

† *Illing*, Allgemeine Wiener med. Zeitung, 1874, Nr. 23, 24, 25.

‡ *Zagorsky*, Mon.-Bl. f. Augenhlkde., 1867, p. 322.

left-sided facial paralysis in a patient 35 years of age, which entirely disappeared in a few weeks. *J. Hirschberg** reported two cases which he had observed. The first presented a right-sided, well-defined, symmetrical defect in the visual field, with aphasia and hemiplegia of the right side, normal vision, and normal fundus; *post-mortem* revealed a tumor situated in the left hemisphere, which had interrupted the functions of the left optic tract. The second case was one of right-sided hemiopia, with defined symmetrical defects; the line of separation ran vertically 3° to the right of the point of fixation. The left fundus oculi was normal, the right showed partial atrophy of the nerve. There was diminished mobility of the right lower extremity, without pronounced paralysis. *Jackson*† also described a case of bilateral hemiopia in which the conclusion was given that there was a softening and depression of the posterior portion of the right optic thalamus, which, upon section, presented a grayish-yellow color. The softening, most pronounced to the inner side, extended toward the wall of the ventricle, but was confined to the optic thalamus. Microscopic examination revealed the usual conditions of softening of the brain. *Hirschberg* and *Jackson* advance their cases as proof against the theory of total crossing. I have observed the following case at the university clinic of Prof. *Mauthner:*

Joseph Jud, a carpenter from Milo, aged 71, stated that during the active period of his life he had fallen twelve times from roofs, as the result of which there was a shortening of the left leg from fracture of the neck of the femur, and he suffered from double inguinal hernia; otherwise he enjoyed good health. He asserted that his near vision had always been good up to about twelve inches, but that he never could see as perfectly at a distance as many of his acquaintances. On February 7th, 1875, after Sunday service, he sat in an inn, in company with several comrades, refreshing himself with a glass of brandy, and being unable to tear himself away from the cheerful company, he imbibed a little too freely, and, as oft before, staggered home in a rather happy frame of mind. Arriving there, he (being a bachelor) cooked his own dinner, and while thus occupied there came over him suddenly a trembling; he felt conscious

* See the preceding article, p. 188.

† See Wiener Med. Wochenschrift, No. 35, 1875.

that things were not as they should be, but failed to appreciate his true condition. He spoke of his sensations to the people of the house who were present, ate his meal, and went to bed. After resting a few hours he went to vespers, but noticed on the way to church that he brushed by and stumbled against those passing him on his right side, without seeing them. This affection of sight remaining unchanged, caused him to seek relief at the University clinic on the 15th of February. An examination revealed the following conditions: The tension of both eyes was somewhat greater than normal, the pupils corresponded in size to the patient's age, but reacted rather slowly upon changes of light. Neither external nor ophthalmoscopical examination showed indications of other pathological changes. Sensitiveness to light proved normal, as tested with *Förster's* photometer. Vision, according to Snellen's test types, was about $\frac{10}{20}$ with $\frac{1}{36}$ right, fully $\frac{10}{20}$ with $\frac{1}{36}$ left.

Fig. 5 represents the visual fields of the right and left eyes, as taken

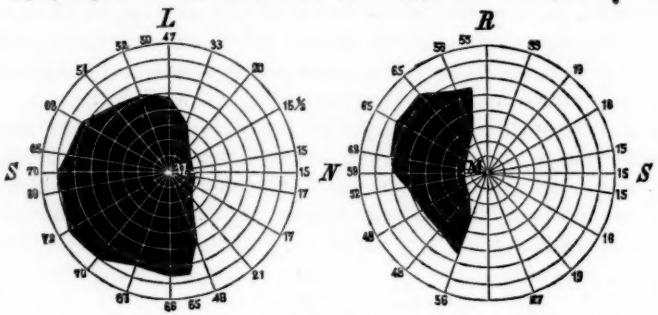

FIG. 5.

with *Förster's* perimeter. The defects are sharply defined. The line of separation, which runs nearly vertical, does not pass directly through the point of fixation, but a trifle to the right thereof; still, the distance is so small that with the perimeter the white square comes completely to the object of fixation; the latter consisted of a white point in place of the fixation ball, which I removed. The contrast, on the contrary, is quite remarkable when an object at a great distance is fixed. No peripherical contraction of the visual field showed itself; still, there was a receding of the line of separation from the perceptive portions, above and below in the left eye and below in the right eye. Binocular vision was completely preserved in the percipient halves of the retinæ, as shown by tests made with *Hering's* and *Meulen's* fall apparatus. The conditions remained unchanged at the end of six months.

The disease under consideration is often preliminary to the appearance of a so-called apoplectic attack, with paralysis of the same side of the body as the hemiopia, and of the corresponding facial muscles; exceptionally also of the opposing facial muscles (*Alexander* *). In right-sided hemiopia aphasia is observed, together with, or independently of, the above-named symptoms; but pronounced paralysis often fails to appear. The patient has a feeling of formication in the extremities, which becomes at times very great; speech is somewhat impeded, and vertigo occurs. Occasionally every symptom of cerebral disease is absent except severe headache. All of these disturbances may retrograde or disappear in time, including the visual trouble (*v. Graefe, Zagorsky, Cohn*), or the latter may alone persist. It is particularly to be noted, that a limitation of the field, having once occurred in this form of hemiopia, never increases or leads to complete blindness, if no other complications arise, a quality only rarely approached by the previously described forms.

Soon after the commencement of the affection, the ophthalmoscopic picture is usually negative, but sometimes the outer half of the papilla appears pale; *v. Graefe* described a case of left-sided hemiopia, where, after three years' duration, both right halves of the papillæ were atrophically excavated; and, upon the semidecussation theory, explained it by the acceptance that the nerve fibres of the fasciculus cruciatus were particularly distributed over the inner halves of the papillæ, hence the fibres of the fasciculus lateralis turn outward, consequently the above relations must obtain with paralysis of a tract. *Mauthner* observed, in a case of right-sided hemiopia of thirteen years' duration, atrophy of the right optic papilla, with a normal left disk. He denied the above explanation of *v. Graefe's*, and asserted that the appearance of the surface of the papilla depended exclusively upon the condition of the fibres of the crossed bundles, as the latter not only radiate upon the inner half of the papilla, but also run outward, in order to extend as far as the centre of the fovea centralis, so that the fibres of the uncrossed bundles lying un-

* *Alexander*, Zehender's Klinische Mon.-Bl., 1867, p. 88.

derneath the others go directly outward, or rather above and below, but disappear mostly in the inner half of the opticus, beneath the fibres of the crossed bundles, in order to curve outward and reach their destination. *J. Hirschberg* has described a similar case. *Schön* noted paleness of the disks in case No. 22; neuritis and marked swelling of the papillæ in No. 23; general indistinctness and paleness in case No. 24, and white atrophy of both papillæ in No. 26. *Hjort* observed atrophy of the right nerve with left-sided hemiopia, with hyperæmia and obliteration of the margins of the left disk.

Those who have observed cases of bilateral hemiopia which were not examined by the perimeter, assert that the line of division between the perceptive and amaurotic portions of the retina very frequently ran wholly vertically through the point of fixation. This occurrence may be stated as a general rule. On the other hand, several authors observe that the perceptive portions of the retina are not infrequently involved, without, however, expressing themselves farther as to the kind and manner of the limitation. The relatively numerous cases which have latterly been examined with the perimeter, and the resulting precise knowledge of the forms of the visual field, throw light upon the above relations. It may happen, as illustrated by *Mauthner's* case, that there is a normal acuity of central vision with each line of division, vertical, and at the same time drawn through the point of fixation; finally, that the extent of the still perceptive portions may remain perfectly normal in all directions. I might represent such cases as the truly ideal bilateral hemiopia, a picture which, to be sure, is only rarely met with in such completeness. The line of division often offers deviations of the most diverse kinds, as well from the vertical as from its course through the point of fixation. It may either be displaced some degrees above and below toward the blind halves, or removed *in toto* toward these parts, becoming thus irregular, zigzag, or forming in the centre, near the point of fixation, a knob-like projection in the same direction, while the ends recede both above and below, so that sometimes a very considerable falling off exists for the visual halves of the field at these peripherical spots. These variations may compensate each other in the two eyes, so

that for the excess in one eye there may be a corresponding falling off in the other, so that the union of the two halves may constitute a normal field. It also sometimes happens that this construction is otherwise, the visual fields of both eyes partially extend over one another, or are defective. These encroachments of the field show moreover that the sensitive or percipient halves of the retinæ are frequently not intact peripherically, and that they often fail to retain the limits of a normal field. The defect does not usually exceed 5–12°, but *Cohn*, *Förster*, and *Schön* have delineated fields in which the contraction amounted to 50°.

The question now arises as to how we shall explain these clinical facts.

Cohn * demonstrated diagrammatically that the defects in the field of this form were even less explainable upon the theory of partial crossing of the fibres in the chiasm than of nasal hemiopia. We must then accept that besides the effusion of blood which paralyzed one tract, a second one should be present which disabled the fibres of the other tract, thus causing the peripherical defects in the preserved portions of the field above alluded to. But this is in the highest degree improbable, on account of the frequency of these cases, whereas, according to *Mandelstamm's* theory, all forms of hemiopia and the peculiar defects of field are explainable by a total crossing. For instance, a spot of disease in the outer angle of the chiasm must give rise to bilateral hemiopia, because it affects at the same time the fibres of the tract and nerve which form the angle. *Mandelstamm* believed that lateral hemiopia was much more naturally explained in this way than by the semidecussation theory, because the outer angle of the chiasm from its great vascularity offered the best situation for embolism, extravasation, etc., whereas the tract in its course to the corpora quadrigemina did not offer this chance, and besides, the localization of the disease permitted of considerable latitude. *Cohn* now explains by the same theory the peripherical limitations of the preserved fields, by the fact that the press-

* *Cohn*, Ueber Hemiopie bei Hirnleiden, Klin. Mon.-Bl. für Augenheilkunde, 1874, p. 203.

ure inducing lateral hemiopia, by acting upon the outer angle of the chiasm more severely, affected parts beyond the middle line of the chiasm so as to incapacitate a portion of the percipient halves of the retinæ, upon the supposition that the fibres supplying the periphery of the still active part of the retinæ lie nearer the middle of the chiasm than those providing the more central portions of the same.

Illing called attention to the fact that the line of division in his case did not run vertically nor pass through the point of fixation. "But, on the other hand," he adds, "neither the preserved portion of the field of the left eye includes defects above and below, nor does the defective parts of the field manifest a similar behavior in relation to the preserved zone in the same eye, as finds its explanation according to *Mauthner's* arrangement of the nerve fibres. In order to avoid any misunderstanding, I would observe that *Mauthner* represented that the uncrossed bundles supplied with nerve fibres the retina to the outer side of a line drawn vertically through the fovea centralis, while the fibres of the crossed bundles ramified to the inner side of the line; hence, in paralysis of one tract encroachments of the field should never extend beyond the vertical line. *Illing* ventured a weak experiment, in order to explain the encroachment of the preserved portions of the field into the defective one, upon the semidecussation theory, and came to the conclusion that an incomplete compression must take place, partly of the crossed fibres and partly of the uncrossed ones, so that, whilst the encroachments of the preserved field happen in various directions, fibres which do not probably lie immediately near one another in the optic nerve, but are separated by other impaired ones, may maintain their normal condition by involving the latter in the morbid process. *Illing*, however, represented such a condition as extraordinary, not explaining either why the halves of the visual fields do not combine to form a normal field, nor why fibres are impaired which do not belong to the paralyzed tract. He finds this explanation, which should throw light upon all these conditions, in a total crossing of the optic fibres; a hemorrhagic extravasation at the outer angle of the chiasm would impair certain fibres of the outer half of the retina, according to their distribution—for

instance, incompletely above and completely below—together with paralysis of fibres going to the inner half of the retina; a similar condition obtains in the corresponding tract, so that in this manner the deviation of the line of division from the point of fixation and from the vertical direction may be explained, as well as the peripherical limitation of the preserved field.

Cohn's view that the extension of pressure over the middle line of the chiasm impairs those fibres distributed to the peripherical portions of the active half of the retina is contradicted by observations upon temporal hemiopia, from which it appears that the veiling of the field increases from without inward with the progressive growth of the tumor in the anterior angle of the chiasm, corresponding to the compression of fibres in the optic nerves from within outward. Did the nerve fibres in the centre of the optic nerve supply the periphery of the retina, when the morbid cause reached the middle of the nerve the increase in the contraction of the visual field from without inward would be arrested, and a limitation to the nasal side would occur, as is, however, never the case. *Illing* sought to explain the deviations in the form of the field upon the supposition of a complete crossing of the nerve fibres in the chiasm; but his explanation does not solve the limitations in the periphery of the field of the perceptive portions of the retina, and I find the treatment of both hypotheses somewhat erroneous. Normal fibres lying between such as have lost their function are indicated as a peculiarity of occurring semidecussation; if, however, we accept the existence of a total crossing, and after *Illing* analyze the cases which *Cohn*, *Förster*, and *Schön* have graphically drawn with the perimeter, we may easily convince ourselves that the above relations, denounced as exceptional, must here take place in a double manner in the tract and nerve; moreover, the direction and effect of pressure in the outer angle of the chiasm, as held by *Illing*, is not at all plausible, for to me it is difficult to understand, that an extravasation of blood should produce directly opposite effects in two spots lying close to one another.

Hence, the theory of total decussation offers not the slightest advantage over that of semidecussation in explaining the above-

mentioned conditions; it still appears that the outline between the perceptive and non-perceptive portions of the retina is almost without exception sharply defined, and with only relatively slight fluctuations from a perpendicular passing through the point of fixation, so that the union of the two halves of the field at least approximates a normal field. Farther, in considering the delineation of the field, it is not to be misconstrued that the peripherical contraction of the perceptive halves always occurs to a greater extent in the temporal portions. If we add to all this those symptoms (which frequently accompany hemiopia) of transitory or permanent hemiplegia and facial paralysis, which pressure in the outer angle of the chiasm could not possibly cause, this form of disease would hardly dare form a suitable basis upon which the theory of total crossing could take firm root.

The clinical observations are more easily brought into harmony with the physiological and anatomical relations, upon the supposition that the optic fibres only partially decussate in the chiasm. If a hemorrhagic extravasation arising in the outer angle of the chiasm or in one tract should exercise compression upon these parts sufficient to impair the nerve fibres, it must possess a considerable size to cause the cerebral symptom. Because the anatomical relations at the base of the cranium are not such as to prevent the diffusion of an extravasation into the surrounding parts, it is difficult to understand, as already observed, why the pressure should always impair at the outer angle of the chiasm only those parts of the nerve and tract bearing certain relationships; and why should an important extension of the defective parts into the perceptive parts of one or both eyes, and complete blindness, not result by a preponderance in effect, sometimes in the nerve, sometimes in the tract, or by an extension to the middle of the chiasm. But experience affords no such results, hence the subjoined view is highly improbable. However, if there is pressure upon one tract, whose fibres are distributed in a certain manner to both retinæ, complete hemiopia, with sharply defined margins, and with a direction of the division line corresponding to the arrangement of the optic fibres in the retina, arises when the tract is com-

pletely paralyzed; when, on the contrary, there is incomplete paralysis of the tract, the encroachments of the perceptive half of the field correspond to the position of the preserved fibres. No symptoms of cerebral disease may be present, or only such as might be explained by an extravasation causing increase of intracranial pressure and anæmia. An effusion of blood need not limit itself to one tract, for by extending backward or overreaching the median line paralysis and paresis of different cranial nerves, and in part of the other tract, may be produced; the latter being more apt to occur the nearer the chiasm the effusion has taken place. Supposing it to be the case that those tract fibres lying nearest the median line supply the nasal portions of the retinæ, and that the more peripherical fibres of the tract also conduct impressions to the brain from the periphery of the nasal halves of the retinæ, then injury of this portion of the tract must produce a defect in the periphery of the preserved nasal fields. These deductions are fully justified by the clinical observations above given. The localization of the hemorrhage, tumor, or pathological change permits of conjecture when the accompanying manifestations of paralysis are considered. For instance, in case No. 4 of *Cohn* and No. 21 of *Schön*, where all paralytic symptoms were absent, but the injury to the preserved fields quite distinct, it is possible that the extravasation, instead of extending backward, was diffused nearer the chiasm and against the opposite tract, causing paralysis in a manner corresponding to the defects in the fields. In the first case, upon absorption of the hemorrhage the second tract became free, and the visual field extended itself to one of pure hemiopia. The autopsy appearances published by *Hirschberg* and *Jackson* are highly important in forming a judgment upon the relations of the optic fibres in the chiasm; they relate to tissue changes in *one* hemisphere of the brain which produced hemiopic affections in both eyes.*

I accidentally observed the *post-mortem* upon a man 57 years of age, who had lost his left eye (by an injury some twenty years previously, so that only a small stump was to be seen. The nerves and tracts presented similar conditions to those found by

* See Dr. Pooley's case, in this number.—ED.

Gudden in his experiments upon dogs; both tracts were smaller than the right optic nerve, and the left nerve and right tract were particularly atrophied. Unfortunately, the decomposition and serous infiltration permitted no accurate measurements to be taken.

*Mauthner** has described a fourth kind of limitation of the visual field, arising from cerebral causes, and characterized by a defect *upwards*. The uniformly dark portions of Fig. 6 represent

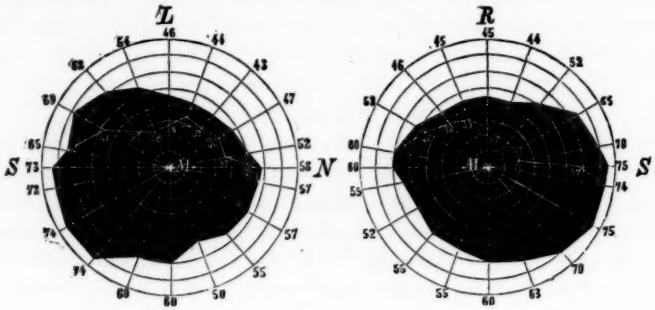

FIG. 6.

the extent of the fields in the right and left eye of *Mauthner's* case, as obtained by the perimeter.

Upon request the patient gave me the history of his affection, which I will communicate. Six months after the last examination, on the 13th of March, 1872, the patient, who had been feeling relatively well up to this time, had an epileptiform seizure which continued about four minutes and terminated with severe vomiting. Such attacks were repeated monthly until the summer of 1874, when they occurred at intervals of three to four months; but during the past three months they have again been repeated about once in every four weeks. He experiences a feeling of increasing heat in the head one or two minutes before the seizure, and his forehead is covered with drops of perspiration; dizziness then comes on, with loss of consciousness and severe convulsions. He feels somewhat weak after the attack, but not otherwise unwell. Conditions producing cerebral congestion and mental or bodily excitement always endanger a

* *Mauthner*, Zeitschr. f. prakt. Heilkunde, 1872, No. 24.

repetition of the attack. I made an accurate examination of the case August 2, 1875. Central vision proved to be S=$\frac{5}{20}$. The patient previously stated that his peripherical vision was decidedly improved upward and outward. The perimetric examination particularly interested me, as I could demonstrate a completely normal visual field, as is evident in Fig. 6, from the contrasted portions. The outlines remained without perceptible change even upon imperfect illumination. The apparent limitation of the field upwards is due to the very marked prominence of the upper margin of the orbit. The epileptiform attacks which appeared after *Mauthner's* observation of the case induced him to diagnose a slow-growing, flat-like tumor at the base of the cranium. It is interesting, for, as the restoration of the visual fields indicates, the optic fibres either adapted themselves to the pressure, or those near the tumor were swollen for a long time.

From the above views I am led to the following conclusions:

1. *Temporal hemiopia* is alike intelligible, whether the nerve fibres entirely or partially cross in the chiasm; therefore I might represent it as arbitrary and *Mandelstamm's* explanation in no manner justifiable that these cases (of *Sämisch* and *E. Müller*) were neither for nor against *Müller's* semidecussation theory, *but rather in favor of a total crossing.* The same may be said of the single case of bilateral hemiopia *upward.*

2. The interpretation of *right* and *left-sided* hemiopia offers many difficulties. The impairment of vision *per se*, but more particularly the accompanying appearances of paralysis, render the theory of total decussation highly improbable. The latter conditions are more in favor of semidecussation, for the exciting causes may be localized from the tract to the corpora quadrigemina and optic thalami, as has in reality been done from successful preparations obtained.

3. Those cases which have been described as *nasal* hemiopia, induced by pressure upon the posterior angle of the chiasm or by the pressure of pathologically changed arteries upon the outer borders of the chiasm, must be taken in the sense that the defects in the fields were caused by equilateral neuro-retinitis, independently of the central disease. The distribution of the nerve fibres in the chiasma nerv. opticorum is not here brought at all into consideration.

Thus, it seems to me that the interpretation of the clinical observations affords no support to the theory of total crossing, neither does it oppose the theory of semidecussation; whereas, the physiological speculations of *J. Müller* and the experiments of *Gudden*, as well as the pathological changes, undoubtedly favor the latter theory. The fulfilment of the hope that pathological anatomy, together with clinical observation, may solve the enigma of this disease, and bring into harmony the results of the last-mentioned authors, need not be far distant.

FIVE CASES OF SYMPATHETIC OPHTHALMIA.

Reported by Dr. S. C. AYRES, of Cincinnati, O.

THE question of the cause, development, and relief, or prevention of sympathetic ophthalmia, is one of deep interest to every specialist. This disease is often so slow and insidious, that it has developed its full force before the patient becomes alarmed and applies for advice. At other times it develops with wonderful rapidity, and goes on to total destruction of the eye, apparently regardless of all attempts to check it. It is, without doubt, one of the most intractable and destructive diseases we have to deal with, and can profitably be studied in all its different phases. It is the sword of Damocles hanging over the head of nearly every patient who has been so unfortunate as to lose one eye, threatening destruction of its fellow. How to avert its deadly fall is the question of vital importance.

We are particularly warned against the dangers of sympathetic inflammation in cases where a foreign body has penetrated one eye, but it is a question whether such cases are in fact more likely to be followed by this fatal disease than other wounds. My observations lead me to conclude that punctured and incised wounds, involving the cornea, iris, and ciliary body, are, in general, more productive of sympathetic trouble than foreign bodies remaining within the eye.

In thirty-five enucleations made by Dr. Williams and myself, for foreign bodies within the eye, only *one* case of sympathetic inflammation occurred. In these cases the foreign bodies had remained in the eye during different periods, varying from one day to twenty-three years. In all of them sympathetic irritation, photophobia, lachrymation, spasm of accommodation, and diminished acuity of vision were present to a greater or less extent, but in none (with the exception of *one* case) was there plas-

tic iritis or irido-cyclitis. All of the thirty-four cases recovered with good vision in the uninjured eye, and there has been no subsequent trouble so far as heard from.

I have excluded from this report many cases of probable sympathetic inflammation which were not seen until after the inflammatory process had exhausted itself and both eyes were blind.

In some of these the history was too unsatisfactory to be recorded, while at the same time the probabilities were in favor of the loss of the uninjured eye by sympathy.

The cases reported below were seen during the acute stages of inflammation, and the histories are clear in regard to the injuries.

Case 1.—Injury of the right eye by the beak of a bird. Sympathetic inflammation of the left eye in nine months, and loss of vision.

W. M. M., æt. 9, a bright, healthy boy, met with the unfortunate accident which caused the loss of his eyes in the following remarkable manner, as related by his father. He was standing near a cage in which a wild bird of the crane species, recently captured, was confined, and while the boy was looking through the bars the bird struck him with his beak. The wound inflicted was in the upper and outer quadrant of the cornea, crescentic in shape, and about 2‴ in length. He suffered but little pain after the injury, although there was probably a prolapse of the iris and traumatic cataract. He retained perception of light for about four months, when it failed entirely.

His father first noticed, in July, 1875, four months after the injury, that the sight of his sound (left) eye was not quite as good as usual, but the symptoms were not severe enough to excite his fear of any threatened trouble, and it was not until December, eight months after the injury, that he became fully convinced that his left eye was sympathetically affected.

At this time the injured eye became red and irritable, and, at the same time, the left eye began to fail very perceptibly, and he was soon unable to read. Since then it has gradually failed, and he is now only able to count fingers at 4′ and read Sn. 20 at 2″.

Status præsens.—Right eye: Eyeball diminished in size, T—2, cornea flattened, sclerotic injected, corneal diameter diminished, complete anterior synechiæ, anterior chamber obliterated, eye tender to pressure. Left

eye: Normal in size, T—1, pinkish zone around cornea, complete posterior synechiæ, iris dirty, rusty color. There is a dense, false membrane in the pupil.

Enucleation of injured (right) eye advised, and performed March 22, 1876.

March 23d.—Says that he sees objects much more distinctly than he could yesterday. Counts fingers promptly at 7′.

The enucleated eye was examined by making a meridional section through the sclerotic. The vitreous was entirely disorganized. The ball was filled with a fluid of a dark amber color, in which were floating numerous roundish, blood coagula. The retina was stretched like a cord from the optic papilla forward to a roundish mass which had developed behind the cornea. The growth was as large as a small hazel nut, and its surfaces were convoluted with here and there minute ecchymoses on the surface. It seemed to have developed from the iris and ciliary body. The lens was entirely absorbed; only a portion of its thickened capsule remained. The ciliary processes on the injured side of the cornea were atrophied and seemed to have become a part of the neoplasm.

April 5th.—Case progressing favorably. He now walks around without stumbling, and without assistance. Vision is about $\frac{6}{100}$, and he spells Sn. No. 20 at $3\frac{1}{2}$″. He counts fingers in a moderately lighted room at 8′. Pupil slightly dilated.

May 10th.—His father reports that his vision is not as good as it was last month. He sees with difficulty to go around, and it is quite evident that degeneration of the eye is going on.

Case 2.—Injury of right eye by fragment of iron ore, sympathetic inflammation in nine weeks, and loss of vision.

W. R. R., æt. 46, laborer in an iron furnace, gave the following history of his case: In the latter part of October, 1875, he was breaking a piece of iron ore with a sledge hammer, when a small fragment flew off and struck the right eye. He had pains in the eye for a while, but soon recovered, and since then has suffered but little from it. There has always been a tender place on the upper portion of the globe, over the ciliary body, and the patient winces when it is touched.

Vision was immediately destroyed by the injury.

Status præsens.—Eye shrunken and T—1.

The inner and lower quadrant of the cornea is flattened, and presents a white, cicatrized appearance. The remainder of the cornea is transparent and the iris is seen through it, and lying in contact with it.

The pupil is filled with the opaque capsule of the lens.

The conjunctiva immediately around the cornea and the subconjunctival tissue are injected, and the sclerotic has a dirty, yellowish appearance.

He could see with the left eye until about the 1st of January, 1876. He then noticed that his sight was gradually failing, that objects in the distance were becoming indistinct; but still he suffered no pain. He has had constantly an appearance of "drops of water" before this eye.

He continued work until the latter part of January, when he had to stop. Since then his sight has rapidly failed, and for the last few days he has had to be led around. He sees only shadows of the hand in front of the eye. The pupil is closed and contracted, and filled with a dense, false membrane. There is considerable ciliary injection, but the globe is not tender to pressure. T + 1.

An instillation of atropine was made, after which he was able to count fingers at 6″.

Left eye enucleated March 16.

He was ordered the Bichlo. Hydrar., $\frac{1}{16}$ gr. twice a day, and $\frac{1}{2}$ 3. ung. Hydrar. to be rubbed into the skin at bedtime.

March 4th.—Counts fingers at 4′ and sees a ring on my finger. The patient is poor and had to return home. The Bichlo. Hydrar. to be continued at home.

May 16th.—Patient has lost ground since he went home. A friend writes that he does not see as well as when he left the hospital. Can still see shadows, but it is evident that vision is gradually failing, and the eye will probably undergo atrophy.

Case 3.—Injury of right eye by fragment of coal, sympathetic inflammation in the other in five weeks, total loss of sight.

C. B., æt. 5, received an injury of the right eye, August 29, 1875, by a piece of coal thrown at her. It inflicted a triangular wound in the cornea, and ruptured the capsule of the lens. There was prolapse of the iris, which was drawn out and snipped off. Suppurative irido-choroiditis rapidly supervened. The patient was a delicate, strumous child, and her confinement to the house and her sufferings told decidedly on her strength; still, with the aid of tonics and good diet she was kept up.

Her left eye remained entirely free from all symptoms of sympathetic inflammation until the latter part of September. The mother had been instructed to bring the child every two or three days, but at this time had failed to do so for more than a week. When seen, October 6, after this

long absence, the anterior chamber of the left eye was more than half full of lymph and pus, and the iris could scarcely be seen at all owing to the turbidity of the aqueous. Vision was reduced to bare perception of light.

Enucleation of the right (injured) eye was now advised, and consented to by the parents of the little girl.

In four or five days after the operation the left eye began to clear up, and steadily improved until the pupil and iris could be seen, and the child was able to go about the room alone and pick her playthings up.

This encouraging state of affairs lasted only a few days, when the eye grew rapidly worse, and in a short time vision was entirely gone. The ball became partly atrophied (April, 1876), and the cornea flattened and opaque. The pain and photophobia disappeared, and the child's eye became comfortable, but vision was nil.

In this case, although the enucleation was made within a few days after the symptoms of sympathetic inflammation began to manifest themselves, yet it had no effect in arresting the disease. If the mother had obeyed instructions, and brought the child in, every two or three days, it might have made a difference in the treatment, but this is at least doubtful.

Case 4.—Injury of left eye by the blade of a pocket-knife. Sympathetic trouble in six weeks and loss of vision.

T. H., æt. 5, a beautiful, healthy boy, met with the unfortunate accident which caused his blindness, in the following manner: He was leaning over his brother's shoulder, who was at the time cutting a string with his penknife. As soon as the string was severed, the knife, carried upward by the impulse, penetrated the left eye at the outer margin of the sclerotic and directly over the ciliary body, but did not wound the lens. The cicatrix was situated in the horizontal meridian of the eye, commencing at the sclero-corneal margin and extending outward about 2‴ in length. The eye is normal in size—pupil blocked up by dense, false membrane—anterior chamber very shallow.

The pupil is oval, showing that the anterior chamber must have been opened by the wound. Vision is entirely lost.

About six weeks after this injury was received the right eye began to fail. He never complained of it or suffered pain in it, but his parents noticed that he could not see well. The impairment of vision gradually increased, and at the present time he is barely able to see letters of 20 Sn. at 4″. There is complete posterior synechiæ, the pupil is contracted and

blocked up by false membrane, anterior chamber very shallow, but the T was not diminished. While the iris was discolored, yet it was not vascular, and it was supposed that an attempt at iridectomy would be followed by favorable results.

The injured eye was first enucleated, in the hopes that it would remove the source of irritation and give the other eye a better chance.

Sectio Oculi.—A meridional section of the eye was made, and the vitreous was found partly liquefied and of a pale straw color; the anterior portion, however, retained its normal consistency. Lying directly below the cicatrix was found a clot of blood about the size of a bird shot. The lens was transparent and *in situ*, showing that the knife had passed directly backward without wounding it.

July 30, 1873. Iridectomy made in left eye. The iris was so firmly adherent to the capsule of the lens that it was impossible to remove much, but a small piece was excised. Hemorrhage from the iris interfered with the operation, and the anterior chamber was soon so full of blood that the iris could not be seen.

July 31. No pain in eye; wound healed; anterior chamber still filled with blood.

August 4. Blood nearly all absorbed; coloboma visible; lens covered with pigment from iris; counts fingers at 4″.

Patient now went home with instructions to his father to keep him quiet, and not expose the eye to bright light, and to use atropine.

Returned September 29th, in excellent physical condition. His eye, however, has not improved, and it is quite evident that degeneration of the globe is going on. Tension 1, eyeball flattened at point of incision for iridectomy, iris vascular and in contact with cornea, pinkish zone of injection around cornea, vision reduced to perception of shadows of hand. Was seen afterward in November, when the eye presented very much the same appearance as at the previous examination—V = perception of shadows.

Case 5.—Rupture of sclerotic of the right eye and recovery of good vision. Sympathetic inflammation in left eye and loss of vision.

E. W. M., æt. 38, has in some respects a very remarkable case. He gave the following history: On the night of January 2, 1875, he had occasion to go out to the pump for water. The handle happened to be up, and as the night was dark, he ran against it. It struck the outer

side of the ball, and stunned him severely. Vision was immediately so impaired that he could only distinguish light from darkness.

He treated the injury with cold applications, and in a short time was relieved of pain.

In about six weeks his left eye began to fail. It commenced gradually with a foggy appearance before it, which grew thicker, and in about one month he was only able to distinguish the motions of his hand. The progress of this inflammation was attended with pain in both eyes, but particularly in his left.

He is a delicate-looking man, and as it is now (April 6, 1875), three months since the injury was received, he presents an anæmic appearance, owing to his close confinement and suffering.

Status præsens.—The right eye has suffered a rupture of the sclerotic inwards, *opposite the point where the pump-handle struck the eyeball.* It extends fully one-third around the globe, and is situated in the usual place between the margin of the cornea and the insertion of the rectus muscle. The conjunctiva on the inner half of the globe presents a bluish-black appearance from the amount of blood extravasated under it. Under the conjunctiva, between the cornea and the caruncle, is a roundish elevation which is evidently the dislocated lens. The anterior chamber appeared very deep, and a small segment of the iris can only be seen downwards, the rest of it having disappeared entirely.

The media are turbid, but a faint red reflex can be seen from the fundus. V=shadows of hand. Eye free from pain, and no photophobia.

In the left eye, the pupil was filled with dense, false membrane, there was complete posterior synechia, the anterior chamber was very shallow, the iris appearing almost in contact with the cornea, and there was a zone of injection around the anterior portion of the globe. Within the past week he has had but little pain in it. He can barely see shadows of the hand.

He was ordered to the hospital, where he was instructed to remain quietly in a darkened room, but was allowed to take gentle exercise in the hall when the light was not too strong. He was placed upon the use of *Hydrarg. Bichlo. gr.* $\frac{1}{16}$, and *Tinct. Cinch. Comp.*, ʒj. *bis die.* Instillations of *Sulph. Atrop.* were made three to four times daily.

His injured eye began very soon to show signs of improvement. In three or four days he could count fingers at 1′, and in a week at 4′. He was first tested with Snellen's test type, April 19th, when, with $+3\frac{1}{4}$, his V=$\frac{15}{lxx}$ almost, and he was able to read Sn. No. 6 with $+2\frac{1}{4}$.

His left eye also improved some. The pupil dilated very slightly up-

ward, and he could count fingers at 8″. The iris assumed a more healthy color, and the ciliary injection almost disappeared.

He was now allowed to return home, but was required to keep up the treatment as above until his return.

May 7. Injured eye (right) much improved in appearance. Blood under conjunctiva has almost disappeared, tension of globe normal and vitreous clear. V=$\frac{1}{\infty}$ and reads Sn. 2½.

His left eye is hardly as good as when he left here—still it is not painful and there is no indication for interference.

Aug. 21, '75. During the last three months the right eye has remained unchanged and vision is as good as when last tested. He has no pain in it and with his glasses he sees very satisfactorily. The left eye however has grown worse. There is intense ciliary injection. The tension is increased. Pupil closed with lymph, and iris bulging forward almost in contact with the cornea.

An iridectomy was made by Dr. Williams in hopes that it would arrest the inflammation and that the eye would at last become quiet, even if no improvement in vision resulted. Owing to the fact that the iris was adherent to the capsule of the lens, there was great difficulty in drawing it out, but after several attempts a small portion was removed.

The final result of the operation, April 30, '76, has been that the tension of the eye is now about normal, the ciliary injection has disappeared, and the eye is free from pain, but vision is practically nil.

In an analysis of these cases we note the following points of interest:

In three of them, 1, 2, and 3, the wound was in the cornea and was complicated with prolapse of the iris and traumatic cataract.

In one, case 4, it was situated at the sclero-corneal junction, opening the anterior chamber and causing prolapse of the iris but *not* wounding the lens, and in case 5 there was rupture of the sclerotic with dislocation of the lens under the conjunctiva.

The periods at which sympathetic inflammation developed were as follows: In case 3 at five weeks, in cases 4 and 5 at six weeks, in case 2 at nine weeks, and in case 1 slight symptoms at four months, but none severe until nine months after injury.

In case 3 enucleation of the injured eye was made within a

few days after development of sympathetic trouble, but it had no more influence in arresting the fatal disease than it did in cases 1, 2 and 4, where it was made a few weeks later. The operation seems to have had no effect in retarding or modifying the progress of the disease in any of these cases.

One striking feature in these cases is the freedom from pain in all, with the exception of No. 5, and this may be partly accounted for by the fact that he was a man of nervous temperament, and fully alive to his dangerous condition.

As after-treatment is generally unavailing, we are forced to look to a *preventive* treatment to escape the results of this apparently intractable disease. This must consist in an iridectomy, if made soon after the injury, taking particular care to free the wound of imprisoned iris, and at the same time to remove as much of the lens as possible, when it has been injured. In connection with this we must enforce rest of the eye as well as the body. Use cold externally, atropine, anodynes and in some cases tonics or alteratives as may be indicated.

If plastic iritis or irido-cyclitis has set in, all operative interference, excepting enucleation, may be contra-indicated, and this latter, if the eye is severely injured and likely to become blind, or if any evidences of sympathetic trouble manifest themselves, must be insisted on.

OPHTHALMOLOGICAL REVIEW.

By H. KNAPP and E. GRUENING.

1. Schmidt-Rimpler, Hermann. Die Macula Lutea, anatomisch und ophthalmoscopisch. (*Graefe's Arch.*, xxi., 3, p. 17, etc.)

2. Heinlein, Heinrich, Dr. Zur Makroscopischen Anatomie der Thränenröhrchen. (*Graefe's Arch.*, xxi., 3, p. 1, etc.)

3. Königstein, Leopold. Das Verhältniss der Nerven zu den Hornhautkörperchen. (*Sitzungsberichte der Kais. Academie der Wissensch*, lxxi., p. 297, 1875.)

4. Donders, F. On the Metric System Applied to Spectacles and Ametropia. (*Zeh. Klin. Mon.*, 1875, p. 465, etc.)

5. Snellen, H. Optotypi According to the Metric System. (*Zeh. Klin. Mon.*, 1875, p. 477.)

6. Wecker, L. v. Optometer and Optometric Ophthalmoscope. (*Zeh. Klin. Mon.*, p. 458, etc.)

7. Knies, Max. Zur Lehre von den Flüssigkeitsströmungen im lebenden Auge und in den Geweben überhaupt. (*Virchow's Arch.*, B. lxv., 4, 1875.)

8. Nettleship, Edward. Embolism of Branches of the Art. Centr. Ret. within the Eye. (*The Lancet*, p. 561, Dec., 1875.)

9. Butlin, Henry F. Chondroma of the Lachrymal Gland. (*Transactions of the Pathological Society of London*, 1875, p. 184.)

10. Gayat, Dr. De l'Etiologie Probable des Cataractes Zonulaires ou Stratifiées. (*Annales d'Oculistique Juillet-No.*, 1875, p. 55.)

11. Quincke, H. Ueber perniciöse Anæmie. (*Sammlung Klinischer Vorträge*, N. 2, 100.)

12. Leber, Th. Ueber die Erkrankungen des Auges bei Diabetes mellitus. (*Graefe's Arch.*, B. xxi., 3, p. 206, etc.)

13. Reuss, Dr. A. v. Neue Erfahrungen über Tätowirung der Hornhaut. (*Zeh. Klin. Mon.*, 1876, p. 139, etc.)

14. Steinheim, Dr. Die Behandlung der Amblyopieen und Amaurosen mit Amylnitrit. (*Berl. Klin. Wochenschrift*, N. 17, p. 230, 1876.)

15. Masselon, Dr. Clinique Ophthalmologique du *Dr. De Wecker*

à Paris. Relevé Statistique des Opérations Pratiquées pendant l'Année 1875. (*Cataractes Simples*, p. 7, etc.)

16. MASSELON, DR. Ibidem. (*Iridotomies*, p. 22, etc.)

17. BLESSIG, DR. Neuritis Descendens. (*Zeh. Klin. Mon.*, 1875, p. 420.)

18. WOINOW, DR. On the Decussation of the Optic Nerves. (*Zeh. Klin. Mon.*, 1875, p. 424.)

19. HORNER, PROF. Keratitis Mycotica. (*Zeh. Klin. Mon.*, 1875, p. 443.)

1. SCHMIDT examined the macula lutea of fresh eyes, partly removed from the living and partly from the cadaver shortly after death. If an equatorial section of such an eye is made, and its posterior half submitted to an examination, he finds that the macula appears exactly as seen ophthalmoscopically in the living. The macula presents itself as a dark, brownish-red spot, measuring from 0.8 mm. to 2 mm. in diameter. Its darker shade and its lack of lustre cause it to form a contrast with the surrounding retinal portions. Its shape is generally circular, at times transversely oval—these appearances are only found in fresh eyes. In an eye removed 9½ hours after death, the macula had already changed. In an infant ten days old, the alteration had occurred 6½ hours after death. In both cases the plica centralis had formed, but the yellow color had not yet appeared. If the posterior half of the shell of the eye is kept under observation for some hours, we notice that the retina gradually becomes grey and opaque, that the macula becomes smaller, and assumes a more reddish coloration and a definite outline. At this stage the retina exhibits the picture of what we should regard ophthalmoscopically as embolism of the central retinal artery. Still later the macula presents itself as a mere point, surrounded by a broad, yellow zone. At times the dark centre has the shape of an acute angle or of a V placed transversely. From these observations, Schmidt draws the conclusion that the yellow appearance of the macula is solely due to *post-mortem* changes. G.

2. The lachrymal apparatus has recently been the subject of special study of *Hyrtl* and *Merkel*. Hyrtl, who injected hardening substances into the canaliculi, observed that the casts showed spiral turns and concluded that both the upper and the lower canaliculi had a spiral course. *Merkel* and *Heinlein* oppose this view and maintain that the spiral windings of the canaliculi are caused by over-distention and consequent change of form of the yielding walls of the canaliculi. The *résumé* of Heinlein's investigations is as follows: In children the canaliculi are from 5–6 mm. long; in the adult they may measure from 7–8 mm. Their course is at

first vertical, then curved and finally horizontally inclined. At the point of curvature there are two diverticular enlargements. Owing to the yielding walls of the canaliculi, the vertical as well as the curved portions may be brought into the plane of the horizontal piece, by traction of the eyelid in an outward direction. The entrance into the diverticula is thus narrowed and catheterization easily accomplished. The external wall of the canaliculi is covered by a layer of striped muscular fibres, of which the greater number follow the direction of the canaliculi. G.

3. The mode of termination of the corneal nerves is still a subject of dispute. Some authors hold that the nerves and corneal corpuscles form a continuous network, others, that the nerves anastomose freely without passing through the corneal corpuscles, and others again that the terminations can be followed into the nuclei of the endothelium of Descemet's membrane. The discrepancy of these views led the author to reinvestigate the matter. He placed a cornea previously treated with chloride of gold into dilute hydrochloric acid. This reagent dissolves the substance of the cornea, but leaves the corneal corpuscles and the nerves intact. When after a few hours of maceration the remains of the cornea were examined under the microscope, isolated corneal corpuscles, showing distinctly the finest ramifications of their processes, were seen floating about in the field. Not only the coarser bundles of nerves but also the finest nerve-fibres were preserved and showed their coloration better than before. In order to study the relation of the corneal corpuscles with the nerves, the author utilized only those portions of his preparations, where a few isolated corpuscles or a small group of them could be carefully examined. He found very fine, almost immeasurably fine fibres passing distinctly into the processes of the corpuscles. When the object glass was gently tapped, the corpuscle under examination was drawn out of the field by the slender filament. This experiment was frequently repeated and always yielded the same result. The filaments extended over the whole microscopical field and even beyond it. Their connection with larger fibres, their points of separation from nerve bundles marked them beyond all doubt as nerve fibres. The author never observed a direct transition of filaments into the body of a corpuscle. G.

4. At the meeting of the German oculists at Heidelberg, in 1874, DONDERS was asked to prepare a paper on the introduction of the metric system into ophthalmology, since the discussion of this subject had not yet led to a general union. Donders accepted; and, at the meeting of 1875, submitted his report, which substantially is as follows:

The old system has two principal faults: 1. The dioptric unit is dif-

ferent, since Paris, Prussian and English inches are not the same. 2. It is too great, since a glass, or a degree of ametropia reaching the unit of one inch hardly ever is found. We have, therefore, constantly to employ fractions. Donders recommends the proposition of *Nagel* and *Monoyer* to adopt a lens of one metre focal distance as refractive unit and give it the name "*dioptrie*," according to Monoyer. This glass receives the designation 1, and its focal distance :

1	metre	is equal to	36.94	Paris inches.
1	"	"	38.23	Prussian "
1	"	"	39.37	English "

The subsequent numbers are 2, 3, 4, etc., which means glasses of two, three, four times, etc., the refractive power of the one-metre lens (Nagel) or dioptrie (Mon.) Thus :

1	has a	focal distance of	1	metre.
2	"	"	$\frac{1}{2}$	"
3	"	"	$\frac{1}{3}$	"
4	"	"	$\frac{1}{4}$	"
10	"	"	$\frac{1}{10}$	"
20	"	"	$\frac{1}{20}$	"

It is easy to convert the inch system into the metric, since, of the metric system,

No. $1 = \frac{1}{38}$ (Prussian inches).

" $2 = \frac{2}{38} = \frac{1}{19}$

" $4 = \frac{4}{38} = \frac{1}{9\frac{1}{2}}$, etc.

The strongest glass, 20, is equal to $\frac{20}{38}$, therefore a little stronger than $\frac{1}{2}$.

To find the dioptries of any glass of the old system, we have but to multiply it with 38, for instance :

$$\frac{1}{7} = \frac{38}{7} = 5.5, \text{ etc.}$$

We want weaker glasses and smaller refractive intervals than the dioptry, for practical purposes half and quarter dioptries, 0.5, and 0.25, and for scientific purposes fractions of even 0.1 dioptrie. The glasses which are in trade adapt themselves satisfactorily to the new system, so that we need only transcribe the numbers of the old system into those of the new. It is to be expected, however, that opticians will soon furnish the glasses strictly according to the metric system, and the optician, P. Roulot, No. 3 Rue des Vieilles Haudriettes, Paris, already offers complete trial cases according to the metric system, for 220 francs. K.

5. SNELLEN has issued a new edition of his test types according to the metric system.

6. WECKER has constructed another ophthalmoscope which contains in a rotating disk, one empty circle, and twenty convex glasses, arranged according to the metric system from 0.5, 1, 1.5, 2, 2.5, 10, that is, from $\frac{1}{72}$ to $3\frac{1}{2}$. The refractive intervals are equal $\frac{1}{72}$, or 0.5 dioptrie. A like series of concave numbers is obtained by placing a concave 10.5 (dioptrie) behind the aperture of the mirror and rotating the disk with the convex numbers as usual. This will give the concave numbers by easy combinations, for instance +10 combined with −10.5, gives −0,5 ; +9.5 with −10.5 = −1 ; +0.5 with −10.5 gives −10.

This simple and ingenious arrangement is the consequence of the equal refractive intervals. It has the disadvantage, however, that it requires in the stronger numbers far more glasses than are of practical use ; for instance, if we count from $\frac{1}{7}$ (inch system), the series is 7, $6\frac{1}{2}$, 6, $5\frac{5}{7}$, 5, $4\frac{3}{8}$, $4\frac{1}{8}$, 4, $3\frac{3}{4}$, $3\frac{1}{2}$. If the series were continued to No. 2, it would add a multitude of useless glasses. The small refractive intervals in the stronger glasses are useless, since they can be replaced by moving the head toward or from the eye observed, and, unless the distance of the head is measured accurately, they are unreliable. In this new ophthalmoscope, Wecker had to introduce this superfluity of strong convex glasses, since he wanted it for the formation of the weak concave glasses.

K.

7. Dr. MAX KNIES reports the results of a series of experiments undertaken with the view of determining the direction of the current of the nutritive fluids in the interior of the eye. He injected ferrocyanide of potassium into the vitreous body of living rabbits and decapitated the animals a few hours later. The examination of the eye showed a steady increase of the intensity of the blue coloration from behind forward. At the optic nerve entrance the blue coloration was only slight, but intense around the margin of the lens where the hyaloid membrane arches in between the lens and the ciliary body. Furthermore the canal of Petit and the posterior lens capsule were distinctly tinged. The lens substance had a slightly bluish hue. The anterior portions of the retina were likewise somewhat colored, while the choroid remained unchanged. The ciliary body and the iris were decidedly blue. The anterior chamber showed only slight traces of Berlin blue. At the ciliary attachment of the iris a marked coloration was seen. In some specimens Descemet's membrane and its adjoining corneal lamellæ were somewhat tinged, the intensity of the coloration decreasing from the periphery of the cornea toward the

centre. In every preparation a circumscribed intensely blue spot was situated either within or in front of the meshwork of the ligamentum pectinatum. Further investigations showed that the intercellular substance between two rows of endothelial cells of Descemet's membrane was intensely colored, the coloration extending in the shape of a ring around the whole cornea. In meridional sections a well-defined blue line was seen to pass through the membrane of Descemet into the cornea and then to turn backward at a right angle. The blue line took its course through the substance of the sclerotic, between the middle and inner third of its thickness, and gradually disappeared behind the equator. The conclusions drawn from these experiments are summed up by the author in the following manner:

1. There exists in the interior of the eye a general current of fluid in the direction from behind forward.

2. This current is also demonstrable within the lens.

3. The nutritive fluid enters the lens from the vitreous body, its current thus following the course of the fœtal hyaloid artery. The current passes through the intercellular substance.

4. The cornea is furnished with nutritive material from the anterior chamber through the intercellular substance.

5. The aqueous humor is a mixture of an exudation derived from the ciliary body and a fluid which has passed through all the inner parts of the eye.

6. The aqueous humor issues from the anterior chamber in two ways: firstly through the cornea into the subconjunctival tissue, and secondly through Fontana's space into the sclerotic.

7. Paracentesis of the anterior chamber accelerates the nutritive current in the interior of the eye, especially in the lens.

8. The intercellular substance must be considered as the carrier of the nutritive fluid, both for the cells of the parenchyma and the connective tissue. G.

8. Nettleship describes the case of a girl, æt. seventeen, who, while dressing, noticed that her left eye suddenly became blind. Within twenty-four hours sight partially returned. Two months later she consulted N., who found a defect of the visual field occupying the whole outer-upper and an adjacent part of the inner-upper quadrant. Central S $\frac{20}{20}$. The OS revealed a milky haziness of the lower-inner and part of the lower-outer portion of the retina; the disk was paler than that of the other eye, and the retinal arteries, especially the lower, were considerably diminished in size. There were two small, round spots of black pigment in the lower

part of the fundus, probably the result of hemorrhage. Eleven months later, S and F were the same. No perception of light in the defect, the boundary line of which was sharp, S in the remainder of F normal. The lower divisions of the retinal artery (two or three in number) were so extremely diminished that they could not be traced beyond the lower border of the disk. N.'s opinion is that, without a doubt, this was a case of embolic obstruction of the lower and inner divisions of the a. centr. retinæ. He discusses the recorded cases of this disease, the majority of which have been published in these archives. K.

9. The tumor was removed by Mr. VERNON, at St. Bartholomew's Hospital, from the orbit of a man 28 years of age. It had been growing for about nine years. The deformity produced by the growth was most striking. The eyeball was pushed downward, and lay almost entirely beyond the margin of the orbit; the conjunctiva was congested; the sight of the eye considerably impaired. A longitudinal incision was made through the upper lid, and through this the tumor was removed. Owing to the thickness and strength of its capsule, it was shelled out with comparative ease. The wound healed without difficulty; the patient made a good recovery; the eyeball returned to its normal position, and the sight considerably improved. No abnormality was observed either before or after the operation with regard to the moisture of the eye. The tumor appeared to have originated in or implicated the lachrymal gland; its position was close to the bone beneath the outer angle of the orbit. No trace of the gland was discovered at the time of operation. It was enclosed in a thick, firm capsule, was flattened from above downward; of oblong form, measuring $2\frac{1}{2}$ inches by $1\frac{3}{4}$ inches, and about $\frac{5}{8}$ of an inch in thickness. It cut like cartilage, and looked like cartilage, but was not separated into distinct lobes or nodules.

Microscopic examination showed it to consist of cartilage, the form of the cells and the characters of the matrix varying much even in different parts of the same section. The sections were irregularly mapped out into lobes or divisions by trabeculæ of fibrous and cell tissue. In some of these trabeculæ were found what appeared to be remains of gland tissue, namely, follicles of small size and of round or oval form, lined, or more or less filled by cells. G.

10. GAYAT has seen two cases of zonular cataract with signs of former iritis. After dilating the pupils with atropine, he found in the first case two very thin shreds extending from the pupillary border of the iris to the anterior capsule of the lens; and, in the second case, deposits of pigment on the lower and inner quadrant of the capsule. These observations

lead G. to assume the probability that iritis in early life may cause zonular cataract. G.

11. In eight cases of pernicious anæmia QUINCKE examined the eyes ophthalmoscopically and found retinal hemorrhages so constantly that he considers this symptom pathognomonic. The hemorrhagic patches were small, irregularly oblong in shape, light red in color and most numerous around the optic nerve entrance and along the vessels. The largest patches attained the size of one-fourth of the papilla, and had obviously been formed by the confluence of smaller spots. The centre of many patches showed a very small, light, greyish-red spot. In several cases the retina appeared somewhat hazy, and the outline of the papilla blurred. In one case the changes were identical with those found in nephritic retinitis. There were white patches, the well-known dotted star around the macula lutea, and, besides, hemorrhagic patches with greyish-red centres. G.

12. While the formation of diabetic cataract is recognized as a frequent occurrence, the affections of the retina and the optic nerve dependent on diabetes mellitus are not yet fully appreciated. Leber has undertaken the very laborious and by no means thankless task to study a great number of recorded cases of diabetes mellitus in order to determine in what manner the organ of sight is implicated in this disease. Aside from cataract he found recorded: hemorrhages into the retina and vitreous; retinitis apoplectica, with or without degenerative white patches; amblyopia, with or without limitation of the field of vision; hemiopia and atrophy of the optic nerves. This variety of affections of the retina and the optic nerve cannot be maintained as a reason against their dependence from diabetes: first, because every one of these affections has been observed in a number of cases; and, secondly, because in morbus Brightii a similar variety of manifestations occurs. Furthermore, we find mentioned as a cause of visual disturbance paresis of accommodation and paralysis of the external ocular muscles. In a case of diabetes observed by Leber, the etiological connection between this disease and the profuse retinal hemorrhages and degenerative changes would not clearly be traced, owing to the co-existence of nephritis. In three other cases of Leber's practice, the ophthalmoscopic examination gave negative results, though the reduction of sight and the limitation of the field were very marked. In one of these cases the left half of each visual field was entirely wanting, while each right half was considerably contracted. G.

13. REUSS reports three successful cases of tattooing of the cornea. The first case was that of a young girl who had lost her right eye by keratitis after smallpox. The cornea was almost entirely destroyed, and replaced

by a shrunken scar, so that the globe of the eye seemed somewhat smaller than normal. There remained only a narrow marginal portion of the cornea, over which the conjunctiva was drawn. As the globe was too large to permit the wearing of an artificial eye, and the patient was unwilling to have the globe either removed or made smaller, R. resorted to tattooing. He succeeded in establishing a beautiful black pupil. The color remained fixed not only in the central cicatricial portion of the cornea, but also in the conjunctiva covering the corneal margin. Thirty sittings were required to accomplish the task. One year later the coloration was unchanged. In the second case the clear cornea was tattooed over the pupillary area in order to conceal a chalky lens. In the third case the leucomatous cornea of a somewhat enlarged eyeball was blackened in twelve sittings. The imitation of a pupil can only be obtained by the use of good India ink and numerous close punctures. R. generally tattoos without speculum and fixing forceps. The conjunctiva is easily injured by the points of the forceps, and the lacerated parts may become permanently blackened by the coloring substance. R. tattoos with Wecker's grooved needle, and prefers this to Taylor's bundle of needles.

G.

14. STEINHEIM treated a number of patients suffering from optic neuritis, atrophy of the optic nerves, and other forms of ocular diseases, with inhalations of nitrite of amyl. He finds that this agent has a most decided therapeutic value in certain cases, and urges ophthalmologists to try it. In illustration of his observations he relates the following case of blindness from profuse hemorrhage, in which the beneficial action of the nitrite was almost instantaneous. A woman, aged forty-two, of sound constitution, was taken ill with profuse flooding, which lasted two days. When the bleeding had ceased she was very pale and so much enfeebled that she was unable to leave her bed. While she was gradually recovering her strength, the sight of both eyes rapidly diminished and became finally extinct. She was examined six days after the supervention of blindness. Externally both eyes were sound, the conjunctivæ pale, the pupils moderately dilated and immovable. The right eye was absolutely amaurotic; the left eye seemed to have a faint perception of light in a very limited district. The media of both eyes were clear, the choroids and retinæ showed no abnormality, but the papillæ of the optic nerves were decidedly swollen, infiltrated with serum and ill defined. The vessels were veiled, the arteries thin, the veins injected and tortuous. Eight drops of nitrite of amyl were dropped on cotton. This was placed under the nose of the patient, who was directed to take deep inspirations. In

half a minute her face became red, her lips turgid, her pulse rapid and she complained of dizziness. When these symptoms had disappeared the inhalations were repeated until the same effect was produced. Fifteen minutes later the sight was examined and it was found that the right eye was still amaurotic but flat, the left eye counted fingers at a distance of five feet. During the following two weeks the patient was treated with daily inhalations of nitrite of amyl. The right eye remained blind, but the left eye had still more improved, and fingers were counted at fourteen feet. Both optic papillæ showed marked atrophic discoloration. G.

15. WECKER operated, last year, on 179 cataracts by his method of extraction with a peripheric flap (see *Ophthalm. Review*, these Arch. IV., p. 465). He instils a drop of eserine (alkaloid of Calabar bean) immediately before the operation, and carefully wipes the eyelids. When the operation is terminated and the iris reduced, another drop is instilled, then the vision is tested, after which a third drop is instilled and the bandage applied.

The 179 cases have given the following results :

In 24 S = 1
" 33 " = $\frac{2}{3}$
" 29 " = $\frac{1}{2}$
" 21 " = $\frac{2}{5}$
" 23 " = $\frac{2}{7}$
" 23 " = $\frac{1}{5}$
" 12 " = $\frac{1}{10}$
165

In 6 S has not been definitely determined.
" 3 there was occlusion of the pupil.
" 2 partial suppuration of the cornea.
" 1 total " " " "
" 1 irido-choroiditis with phthisis bulbi.
" 1 copious hemorrhage and loss of sight.

These results are satisfactory. The first 165 cases give 92% of good sight, and half of them had excellent sight (S $\frac{1}{2}$ to 1).

In 11 cases loss of vitreous during the operation was noted.

In 25 cases a *more or less extensive imprisonment of the iris in the corneal cicatrix was noted.* Several times when an iris prolapse could not be reduced, iridectomy was made.

Wecker operates only the favorable cases according to this method. When the tension of the globe, the mobility and width of the pupil, the consistence and maturity of the cataract, and the depth of the anterior

chamber show unfavorable conditions, he extracts by a combined process (mainly v. Graefe's method).

Among the reasons that have led W. to abandon *Graefe's* excellent method, and seek one by which the pupil could be preserved, reasons which we beg the reader to look up in the original, the following (p. 11 of the brochure) will not be read without enjoyment:

"I will not conceal that the medium in which I live has had a certain influence on me. If we compare an eye on which Graefe's extraction has been successfully performed, with another in which a round, movable pupil has been preserved after the extraction, in a city like Paris, where the taste for the beautiful is so highly developed, we cannot hesitate in our choice. * * * * By the position which I occupy in one of the metropolitan cities, I am obliged to operate in such a way, that nobody can object to me: '*On peut encore mieux faire qui cela.*'" (One can still do better.)

W., as many have done before, wants to individualize, *i. e.*, to find out in what cases the combined extraction is the safest method, and in what an iridectomy is a superfluous precaution and mutilation. If he succeeds in laying down rules by which *others also* can determine beforehand which case should be operated on by iridectomy, and in which a perfect pupil, but without incarceration of the iris, can be obtained, the ophthalmological world will give him their admiration. K.

16. WECKER has performed thirty-five iridectomies last year; *simple iridectomy* five times: three times for zonalar cataract, once for dislocation of the lens, and once for corneal leucoma. Double iridectomy, thirty times: twenty-two times for pupillary occlusions and secondary cataracts, eight times for traumatic cataracts. In correction of a frequent misunderstanding, Dr. Masselon declares that simple iridectomy refers to such cases in which only the forceps-scissors cut the iris; in double iridectomy, however, both the stop-knife and the scissors divide the iris, whereby a linear section with the scissors is mostly sufficient, and a double Λ-shaped section is only exceptionally required. W. adopts the proposition which Dr. *J. Green*, of St. Louis, made at the meeting of the American Ophthalmologists at New York, in 1875 (see Transact. Am. Ophth. Soc., 1876, p. 352), namely, to divide the fibres of the iris at right angles to their greatest tension. The results of the above operations are not stated, but those of some other operators are cited, most conspicuously the communication (Iridectomy by Wecker's forceps-scissors, in the *Med. Rec.*, January 15, 1876), of *Hy. D. Noyes*, of New York, who calls Wecker's operation of iridectomy, if performed with a

very sharp instrument, a surgical triumph. Dr. Noyes made twenty iridectomies and lost only one case, "on account of a defective instrument."

In spite of all this praise, the reviewer confesses his aversion—which may sound like heresy—to cutting with scissors within the eye. There is a reaction period to everything; that of this operation has not arrived yet, and only after it the merit of the operation can be correctly estimated.

K.

17. BLESSIG relates a case of *neuritis descendens vera*, and adds a few important deductions concerning the distinction between true neuritis optica and choked disk, as caused by liquid exudation travelling from the subarachnoid cavity into the subvaginal space of the optic nerve. In true neuritis descendens, he says, the impairment of sight is rapid, of a high degree, and frequently one-sided; whereas, in the choked disk by exudation around the nerve, S declines very slowly, is sometimes astonishingly good, considering the ophthalmoscopic changes, and these changes almost invariably are bilateral. His case was the following: A farmer, æt. 29, without known cause, suddenly became ill with severe headache, vertigo, and vomiting. On the second day the sight of his left eye was impaired. The disease progressed from day to day. On the fifth day the whole left half of the head was painful on percussion. The right eye was normal. In the left S = $\frac{2}{3}$, F complete, the disk moderately swollen, its outlines ill-defined, on and more around the disk numerous radiating ecchymoses. The cerebral symptoms became more pronounced, paralysis of the left oculo-motor nerve set in, and from the tenth day the left eye was totally blind, without alteration in the previously noticed ophthalmoscopic condition. Death on the fourteenth day of the disease, under convulsions and sopor. *Autopsy.*—Purulent basilar meningitis, principally on the left side. The left optic nerve from its emergence out of the chiasm to the eye was one and a half the size of that of the other nerve, and considerably harder. Both sheaths were agglutinated without any interposed substance; "the bundles of the primitive nerve fibres were smaller than those of the other nerve, but the interfascicular connective tissue was greatly more developed, and saturated with nuclei. Thus it is proved that in this case the inflammation of the meninges directly extended to the connective tissue, enveloping and pervading the optic nerve." K.

18. WOINOW demonstrated before the Ophthalmological Society at Heidelberg, in 1875, the eyes and brain of a woman who had lost the sight of her left eye from variolous ophthalmia in her infancy. She died at the age of 50 years. The right optic nerve was normal, the left atro-

phied, the left optic trunk was markedly, the right moderately, atrophied. *Hirschberg*, in the discussion, mentioned that similar observations by *Morgagni* and *Vesalius* are on record. They are in harmony with the elegant experiments of *Gudden* on the dog, which, with like results, have been repeated by *Adamük* on the dog and cat. This experiment also was originated by *Morgagni*, and is minutely described in his epistolæ. The results of these experiments are: In the dog and cat, if one eye or optic nerve is destroyed, the atrophy strikes both optic tracts, but in the rabbit it strikes only the optic tract of the other side.

[The present phase of the question of the decussation is the following: In animals that have no common field of vision, the crossing is total; in others that have a common field, the crossing is partial, corresponding to the extent of the common field. In man there is a half crossing.—Ed.]

K.

19. Horner demonstrated at Heidelberg a cornea taken from a man who had died from facial erysipelas. During the last days of life, a rapidly spreading ulcer had developed in the lower half of the cornea. The centre of the ulcer was crowded with small, round cells; it was surrounded by a zone almost devoid of cells, but pervaded by radiating stripes; then followed a zone which showed the anastomosing network of the corneal nutritive canals choked with *uniformly small and roundish granules*, without any cell-like elements. These granules *Horner* and *Prof. Eberth* of Zurich believe to be bacteriæ, and mention that erysipelas is a disease having, as many believe, a mycotic origin. K.

OTOLOGICAL PART.

HISTOLOGICAL CHANGES IN THE LABYRINTH IN CERTAIN INFECTIOUS DISEASES.

By Professor MOOS.

(Translated by D. F. Lincoln, M. D., of Boston.)

1. Changes occurring in the Labyrinth during Ileotyphus.

In the year 1871 I made a preliminary communication upon this subject in the Transactions of the Heidelberg Naturhistorisch-medicinischer Verein (Sitzungsbericht of August 4, 1871). I have delayed the full publication of these investigations until now, under the conviction that I should have more frequent opportunities than formerly of examining the labyrinth after death from typhoid, and in the desire of reaching a position where I might give a trustworthy and final interpretation of the pathological state. Unfortunately, this expectation has met with a very incomplete fulfilment, for up to the present time I have had but two cases to examine, in one of which the fever had already run its course, while the affection of the ear had begun to convalesce. I will report these two cases further on. If my entire list of observations should prove insufficient to decide the question whether the alterations occurring in the labyrinth are *specific*, that is, peculiar to typhoid, or only *incidental*, that is, such as may occur in the labyrinth as a complication of any tympanitis, I shall still cling to the hope that I myself, or some one of my *confrères*, may be enabled to throw somewhat more light upon the matter by future investigations. In examining this point, I think it of special consequence to select the labyrinth of such typhoid patients as have suffered during life from impaired hearing, without the presence of affections in the middle ear, such as had occurred in my cases.

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The uniformity of the results hitherto obtained from the observations of capable clinicists and aurists has given ground for the almost unquestioned assumption, that there often exists no demonstrable anatomical changes, as the cause of the functional disturbance of the ear in ileo-typhus. This inference has been thought justified upon several grounds. In many cases, the most careful testing of the organ during life showed no alteration, and its function was completely restored when the general disease was cured. In this case the disturbance of hearing was explained as caused by anomalies in the nervous centres, by hyperæmia or anæmia of the brain or meninges, or by the peculiar action upon the brain of the typhus blood (Schwartze).

A further support was lent to this assumption by those cases in which *post-mortem* examination furnished only negative results, so that no material foundation for the disturbance of hearing was demonstrable. Yet it remains uncertain whether the labyrinth was subjected to a careful microscopical examination in *all* these cases.

The positive lesions discovered by autopsy in the auditory organs of typhoid patients may be summed up as follows, according to the statements of the authors named in the previous list:

Catarrh of the fauces with closure of the tuba Eustachii; free secretion in the cavum tympani (Griesinger), often in great quantity; injection of the tympanic mucous membrane; purulent catarrh of the tympanic cavity, with its consequences, perforation of the membrana tympani, dislocation and loss of the hammer and anvil, inflammation and inflammatory maceration of the cells of the mastoid process and of the facial nerve; propagation of the inflammation to the meninges (Schwartze, Hoffmann); inflammation of the parotid gland, with rupture into the external meatus (Virchow, Hoffmann); hyperæmia of the inner ear; in the vestibule, the cochlea, and the semicircular canals (Marcus, Politzer, and Schwartze), ecchymoses in the vestibule and the lower part of the cochlea, but not in the semicircular canals, together with ecchymoses in the tympanic cavity and in the bony tuba (Politzer); finally, Toynbee has observed and described cases of typhus in which the apparatus of the organ was completely annihilated, the nervous apparatus being wholly disorganized, the fluid in the cochlea and the vestibule of a dark color, and tinged with blood.*

* The text does not make it clear whether this condition belongs to the typhoid alone or not. I therefore quote the passage literally (p. 366 of German, 359 of English ed., 1868. The words are from the English text.—*Trans.*):

"As has been stated, in addition to the causes just detailed, the nervous apparatus of the ear often suffers from the action of the poisons of gout, typhus fever, scarlatina, measles, or mumps. Though unable to furnish any information of the *modus operandi* of the several poisons enumerated, in some cases where the functions of the organ have been wholly destroyed, the nervous apparatus of the ear, on dissection, has been found by me completely disorganized, and the fluid in the cochlea and vestibule dark colored and occasionally tinged with blood."

These remarks are probably descriptive of the results of a hemorrhagic inflammation.

To the above-described changes I am now able to add a new one, affecting the finer tissues of the inner ear, which we shall find by no means rare, and which may perhaps assist in explaining certain disturbances of hearing that occur during, or subsequent to, abdominal typhus.

By the kindness of Professor Friedreich I have been enabled to make a series of thorough observations upon this class of deafness. The patients were mostly quartered in the so-called epidemic barracks, erected at Heidelberg during the Franco-Prussian war. The principal complicating affection of the ear in these cases was purulent catarrh of the tympanic cavity, with its consequences. In most cases, the affection was bilateral. The purulent inflammatory character of the disease, and the fact of its affecting both ears in most cases, should not surprise us when we consider that the cases originated during a period of the intensest cold (15° to 24°), after a series of forced marches, privations, and fights, which is well known to every one who has followed the course of events on the Lisaine, at Belfort, etc., from which region most of the typhoid patients came. It was there that the seeds were planted which produced the greatest variety of catarrhal affections, especially of the air passages, which, as our field surgeons and pathological anatomists declare, were often more fatal to our brave soldiers than the wounds received in battle.

Typhoid, therefore, is not the only cause to be reckoned as efficient in producing these aural affections, but the external circumstances must also be considered under which they originated. In the patients whom I examined during life, it was impossible to say whether the purulent inflammation of the ear had developed acutely; it is true that it came early, and usually in the first week of the general disease, but the obscuration of the senses, the frequent somnolence, etc., made the attempt to gain information from the patients useless, and when these conditions had departed, or later still, during or after convalescence, there was no recollection of the first symptoms of the ear complaint. For the same reason, there was no possibility of an accurate testing of the function, and nothing could be said about the subjective sensations of sound which may have been present.

The discharge of pus was extraordinarily profuse in all the cases; almost more so than occurs in the notoriously severe purulent catarrhs of the tympanum, which accompany tuberculosis. In spite of scrupulous cleanliness, the meatus usually filled very rapidly with discharge after every cleansing. But there were no symptoms in any case pointing to an accumulation of pus in the petrous bone, nor even to the formation of polyps.

Loss of substance of the membrane occurred in every case, from a perforation of the size of a pin's head to the destruction of three-quarters of the membrane. I nowhere found marked hyperæmia; only here and there a little injection of the inner end of the meatus and the tympanic membrane, while the line of demarcation between the two was indistinct or imperceptible, owing to swelling of the cutaneous lining of the inner end of the meatus. This lack of decided hyperæmia in the parts affected seems to point to a rather gradual development of the affection; perhaps a certain number of the patients would have had the catarrh independently of the typhoid. The layers of tissue in such portions of the membrana tympani as were left were in most cases thickened.

The other lesions behind the membrana tympani will be treated of more fully in the reports of the autopsies.

One case was complicated with furunculous inflammation in the outer meatus, on both sides.

Of the bodies of soldiers dead of typhoid, which were opened, I was able in three cases to examine the entire petrous bone, in one, only the labyrinth. The labyrinth therefore was examined eight times in all.

Case 1.—Ileo-typhus. Death in the third week.

J. B., Prussian infantry soldier, æt. 25. Entered March 12. Temp. 40°.0, pulse 92. Evening, 40.0, 100. Two stools. Nutrition good. Sensorium obscured. Numerous rose spots on breast and belly. Sounds of heart clear. Pulse dicrotous. Tongue dry. Throat free. Right lung dull, from the angle of the scapula down. Vesicular breathing, with abundant rhonchi. Swelling of spleen. Abdomen soft. Decoction of quinia.

		TEMP.	PULSE.	
March 13,	A. M.	38.5	92	1 stool.
	P. M.	39.5	108	3 stools.
" 14,	A. M.	38.2	100	8 "
	Aphthous mouth. Pencilled with dilute muriatic acid.			
	P. M.	39.2	100	5 "
" 15,	A. M.	39.4	104	2 "
	P. M.	40.2	116	– "
" 16,	A. M.	39.6	100	2 "
	P. M.	40.0	104	1 "
" 17,	A. M.	38.8	108	2 "
	Throat free; slight coating of mucus.			
	P. M.	39.6	104	4 "
" 18,	A. M.	38.0	104	2 "
	P. M.	39.4	—	–
" 19,	A. M.	39.2	114	2 "
	P. M.	40.0	114	1 "
	Delirium; musk, 0.2 * every three hours.			
" 20,	A. M.	39.2	104	4 "
	P. M.	39.7	108	5 "
	Cognac mixture.			
" 21,	A. M.	39.2	104	3 "
	P. M.	40.0	120	3 "
	Half a pint of port wine.			
" 22,	A. M.	39.3	104	4 "
	P. M.	40.2	100	6 "
	Abdomen tense.			
" 23,	A. M.	40.2	104	3 "
	On the right back, dulness from the eighth rib down, with diminished respiration. Small pulse. Champagne.			
	P. M.	40.4	136	3 "
" 24,	A. M.	39.0	108	3 "

* The doses of remedies are in the metric system 1.0 (gramme) = 16 grains; 0.06 = 1 grain.—ED.

	TEMP.	PULSE.	
March 24, P. M.	40.0	140	3 stools.
Meteorism. Three powders of calomel, of 0.30. Death at a quarter to 5 A. M.			

The ear was not examined during life. Autopsy thirty hours after death.

Anatomical condition.—Spleen and mesenteric glands hyperæmic and hyperplastic. Pharynx and larynx normal. Pia mater and brain hyperæmic and very œdematous. Above the valvula Bauhini, large and small ulcers with slightly infiltrated edges, some of which had begun to heal; higher up, smaller ulcers, also of older date; some more recently infiltrated solitary follicles and Peyer's patches. Paralysis of the muscles of the intestine. Compression of lower lobes of both lungs.

Only the labyrinth part of the petrous bone was given me, the rest being reserved for other objects. I can only state that on both sides the mucous membrane covering the promontorium was somewhat thickened and the stapes easily movable.

The membranous labyrinth was seen at a glance to be affected. All its parts were thicker than normal, and looked yellowish-brown. The microscopical examination showed very great vascularity of the utriculus, the sacculus, the ampullæ, and the semicircular canals.

Both these structures and the lamina spiralis membranacea of the several convolutions were for the most part infiltrated with numerous small, roundish, glistening cells, some of which contained fatty granules.

These changes were most distinct at the sacculi and the ampullæ, and at the region of the so-called lid-cells (*Deckzellen*).

Case 2.—Ileo-typhus. Death in the third week.

H. B., artillerist. Received at the epidemic barracks, March 18th. Sick a week before admission.

Temp. 39° C. *Hearing greatly diminished.* Pale roseola in front on the right breast; rhonchi at the right back; spleen swollen to the arch of the ribs: tongue moist, covered in spots with dry crusts: great thirst; skin of abdomen tense; passes stools in bed. Calomel. Some hours after entrance, temperature 39.4° C., pulse, 96.

		TEMP.	PULSE.
March 19,	A. M.	39.0	102
	Three stools in bed; great thirst; tongue dry, a little coated. Restless sleep.		
	P. M.	39.8	102
	Two stools; meteorism beginning.		
" 20,	A. M.	39.6	90
	Four involuntary stools; right front chest, crepitant rhonchi. Behind, on both sides, much vesicular crepitus of medium fineness; no dulness either side; sounds of heart obscured by breathing; throat quite free. *Hearing bad.*		
	P. M.	39.8	112
	Three stools.		
" 21,	A. M.	40.0	120
	Five stools in bed. Right lung in front, fine vesicular whistling rhonchi; in both backs much fine crepitus; abdomen meteoric; bath at 28° R., with cold affusions; temp. 40.6 before bath, 38.8 just after, 39.0 an hour later, 39.7 at 10½ P.M.; five involuntary stools.		
" 22,	A. M.	39.4	120
	Pulse dicrotic, weak; tongue not much coated; coffee twice a day; bath with cold affusion; five stools; discharge from both ears, central perforation in each. Treatment, Arg. Nitr. 0.6 to 30.0 grammes of water, followed by injection of solution of common salt. Abdomen meteoric, not painful; trembling of upper extremities; throat free; 38.0 after bath at 8½ o'clock, 39.0 at 11.		
	P. M.	40.4	142

		TEMP.	PULSE.
March 23,	A. M.	39.9	120
	Eight involuntary stools; crepitus in right lung, calomel 0.3, three doses; preceded by a bath.		
	P. M.	40.0 / 38.8	120
	Six involuntary stools; great trembling after the bath.		
" 24,	A. M.	39.7	112
	At right back some dulness; slight crepitus in left lung; 40.8 before, 37.4 after bath.		
	P. M.	40.2	120
	Five involuntary stools; much crepitus in left lung. 39.9 at 11 o'clock.		
" 25,	A. M.	40.2	104
	Ten involuntary stools; in left lung front, much moist crepitus, and behind on both sides; abdomen soft.		
	P. M.	39.9	116
	Four involuntary stools; abdomen soft, pulse very weak; somnolence. Ordered musk and champagne.		
" 26,	A. M.	40.2	136
	Five involuntary stools; much crepitus in both lungs; pulse very weak; continuous delirium; trembling of the extremities; abdomen somewhat more swollen; bath with cold affusion.		
	P. M.	39.8	142
	Six involuntary stools; pulse continues very weak.		
" 27,	A. M.	39.9	136
	Ten involuntary stools; pulse as yesterday. Numerous crepitant sounds, especially at lower part of right side; body very stiff.		

		TEMP.	PULSE.
March 27,	P. M.	40.2	——
	Five involuntary stools; warm bath, 38.6; pulse too weak to count, 40 respirations a minute.		
" 28,	A. M.	39.6	148
	Seven involuntary stools; abdomen swollen; pulse as yesterday; crepitus in right lung; very brown tongue.		
	P. M.	40.0	152
	Seven involuntary stools.		
" 29,	A. M.	39.7	136
	Six involuntary stools; quiet night; ecchymoses under skin of abdomen. Died in the evening.		

Anatomical Diagnosis.—Ileo-typhus; ulcers of larynx; catarrhal pneumonia of both lower lobes; swelling of spleen; venous hyperæmia and serous infiltration of pia mater; serous infiltration of substance of brain.

Right petrous bone.—In the outer meatus, much pus and epithelium; boundary between meatus and membrana tympani obliterated by thickening of the cutaneous lining. Membrana destroyed, except the border; also the lower end of the handle. The perforation has sharp edges, and at its upper part the end of the stump of the handle is seen. The whole tract of mucous membrane in the middle ear is hypertrophied, the small bones are enveloped in thickened mucous membrane, the tendon of the tensor tympani is destroyed. The articulation of the hammer and anvil is movable, also the plate of the stapes. Periosteum of the vestibule thickened. Antrum mastoideum full of pus. Trunk of auditory and facial nerves and their sheaths infiltrated with blood in the porus acusticus internus.

Left petrous bone.—External meatus as on right side; central perforation of the size of a pea in the membrana tympani, the rest thickened, its posterior border more so, and drawn toward the wall of the labyrinth. When the preparation is looked at from within, it appears that the end of the manubrium mallei forms the lower extremity of the perforation, and, together with its portion of the membrana, is adherent to the wall of the labyrinth. Tendon of tensor tympani separated. Juncture of incus and stapes enveloped in numerous growths of connective tissue passing to the inner wall of the tympanic cavity, and fixed by them somewhat more firmly than usual. Plate of stapes movable.

Microscopical appearances.—In each ear there is an infiltration of small cells, in some places slight, in others abundant, in the sacculi and ampullæ; the same is the case in the first and second convolutions of the cochlea, while there is little in the third, and none at all in the membranous semicircular passages.

Case 3.—Ileo-typhus. Recovery. Development of wandering erysipelas during convalescence. Dysentery. Secondary abscesses in the anterior wall of abdomen and the liver. Purulent parotitis.

J. W., Bavarian infantry soldier, æt. 30, entered February 18. Condition on entrance: Emaciation quite considerable. Tongue coated. Bed sores on left ilium and left shoulder. Parotitis on right side, with several small openings, and a fetid discharge. Percussion and auscultation of the lungs, normal. Abdomen, soft. Temperature, 38.2.

		TEMP.	PULSE.		
March 1,		37.0,	96,	3 stools.	
" 2,	A. M.	36.8,	88,	3 "	Pulse small.
	P. M.	37.2,	92,	2 "	
" 3,	A. M.	36.8,	88,	2 "	
	P. M.	37.5,	112,	2 "	
" 4,	A. M.	36.4,	96,	2 "	
	P. M.	37.0,	112,	2 "	
" 5,	A. M.	36.8,	104,	2 "	
	P. M.	38.2,	108,	1 "	
" 6,	A. M.	37.5,	108,	3 "	
	P. M.	38.0,	112,	2 "	
" 7,	A. M.	37.0,	108,	3 "	
	P. M.	38.3,	116,	2 "	
" 8,	A. M.	37.2,	112,	2 "	
	P. M.	38.2,	116,	2 "	
" 9,	A. M.	36.8,	112,	2 "	
	P. M.	37.8,	108,	3 "	
" 10,	A. M.	37.2,	104,	3 "	
	P. M.	38.0,	116,	2 "	
" 11,	A. M.	37.5,	108,	2 "	
	P. M.	37.5,	116,	2 "	
" 12,	A. M.	37.4,	112,	2 "	
	P. M.	37.5,	120,	2 "	
" 13,	A. M.	37.0,	104,	2 "	
	P. M.	38.2,	104,	2 "	

		TEMP.	PULSE.		
March 14,	A. M.	37.2,	108,	2	stools.
	P. M.	37.3,	120,	2	"
" 15,	A. M.	37.2,	116,	2	"
	P. M.	38.4,	132,	2	"
" 16,	A. M.	37.2,	104,	2	"
	P. M.	38.8,	120,	2	"
" 17,	A. M.	37.4,	108,	2	"
	P. M.	39.6,	132,	2	"
" 18,	A. M.	39.2,	120,	2	"
	P. M.	39.6,			
" 19,	A. M.	40.4,	144,	3	"
	P. M.	39.6,	112,	2	"
" 20,	A. M.	39.8,	102,	2	"
" 21,	A. M.	39.3,	128,	2	"
	P. M.	38.8,	124,	2	"
" 22,	A. M.	38.8,	108,	2	"

Erysipelas in region of right ear. Pulse dicrotic. Strict diet.

Cotton batting to the spot; quinia 2.0 to 180.0, a tablespoonful to be taken every two hours.

The erysipelas is spreading over the left side of the face. Left ear covered with vesicles. The erysipelas stops at the hairy scalp. Much fluid pus in both external meatuses. The inner end of the right meatus greatly swollen, the left less so. In the right membrana tympani, at its upper and anterior part, is a small perforation; in the left, a large one in the lower anterior part. Loud words addressed to him are understood. Arg. nitr., 0.6 to 30.0, followed by injection of common salt solution.

		TEMP.	PULSE.		
March	22, P. M.	38.3,	96,	2	stools.
"	23, A. M.	38.2,	108,	2	"
	P. M.	38.8,	104,	2	"
"	24, A. M.	38.8,	100,	2	" The erysipelas is spreading over both upper arms and the back, as far as the twelfth rib.
	P. M.	39.8,	108,	2	"
"	25, A. M.	37.6,	104,	3	"
	P. M.	39.3,	120,	2	"
"	26, A. M.	37.0,	104,	2	" Erysipelas spreading over arms and breast.
	P. M.	39.7,	120,	1	" Spreading over both sides; upon the left, from the shoulder down in front to the parasternal line, and down behind over back and pelvis.
"	27, A. M.	36.6,	96,	2	"
	P. M.	39.3,	120,	1	"
"	28, A. M.	36.8,	100,	2	" Erysipelas spreading over the inguinal region.
	P. M.	38.6,	120,	2	" Has reached the forearms.
"	29, A. M.	36.8,	108,	2	" Desquamation has begun.
	P. M.	39.6,	132,	2	" A fluctuating tumor at the outer border of left scapula.
"	30, A. M.	36.8,	100,	2	" Urine free from albumen, Sp. w., 1017. Quinia, 1.0 to 180.0, one tablespoonful every two hours.
	P. M.	39.2,	128,	2	"
"	31, A. M.	36.8,	104,	1	"
	P. M.	37.8,	124,	2	"
April	1, A. M.	36.8,	104,	5	"
	P. M.	38.2,	128,	3	"

		TEMP.	PULSE.		
April 2,	A. M.	37.0,	100,	3 stools.	One of the stools contained bloody scraps.
	P. M.	39.6,	140,	3 "	
" 3,	A. M.	36.5,	84,	9 "	Tinct. opii crocata gtt. 8. Black coffee. Wine with liq. ammoniæ anisatus gtt. 10 every two hours.
	P. M.	36.8,	128,	3 "	Small pulse. The erysipelas is starting again on the right cheek; is also spreading over the left cheek and ear.

Death at 12.15 at night. Autopsy twelve hours later.

Anatomical diagnosis.—Cicatrized ulcers in the ileum (typhoid). Proctitis catarrhalis (dysentery). Abscess in anterior wall of abdomen and in liver. Purulent parotitis. Erysipelas.

Examination of the petrous bones:

Right petrous bone.—In the outer meatus abundance of pus; its inner end so swollen as to obscure the boundary between the periphery of the membrane and the meatus. Membrana cloudy, gray, thickened, its centre drawn inward like a tunnel, with a round perforation at the tip of the tunnel, scarcely one mm. in diameter. Manubrium invisible, short process indistinctly seen. In the tympanic cavity an abundance of pus; the pale-red mucous membrane much thickened from here on into the cells of the mastoid process, which, likewise, are full of pus. Malleus and incus movable, enveloped by the thickened mucous membrane; the articular connection between them not lost. Tendon of the tensor somewhat shortened. Tuba free, its mucous membrane pale; in the fossa of Rosenmüller some threads of connective tissue. Plate of stapes (examined from the side of the vestibule) immovable.

Left petrous bone.—External meatus in the same condition as on the right side, but with a clearer limiting line between it and the membrana tympani. The greatest part of the anterior half is perforated. The rest is only thickened in its upper half, but not below.

The end of the manubrium stands a little off from the rest, and is drawn more toward the promontorium; the articulation between stapes and incus is luxated. From the posterior segment of the membrane a

quite thick and broad false membrane passes under both legs of the anvil to the inner and posterior wall of the membrane. The tendon of the tensor is present, somewhat shortened. The plate of the stapes is easily movable in its anterior half, scarcely at all in the posterior (tested from the side of the vestibule). In other respects the middle ear is like that of the right side.

The examination of the inner ear, performed on both sides, showed a rather strong yellowish coloring, but nothing else of striking note.

The microscopical examination showed a similar condition on both sides. The lamina spiralis membranacea infiltrated with small, round cells, mostly lying together in groups; these were most numerous in the region where the nerves perforate; less so, yet abundant in the neighborhood of the so-called lid-cells, while further outward the amount of infiltration gradually diminished. The same features were observed in the ampullæ, and at their point of junction with the semicircular canals, but not in the latter.

Case 4.—Ileo-typhus.

H. M., æt. 22, Prussian infantry soldier. Entered March 12.

		TEMP.	PULSE.		
March 12,	A. M.	39.8,	112,	– stools.	
	P. M.	39.5,	96,	– "	Calomel, hydrochloric acid, ice-bag.
" 13,	A. M.	39.2,	104,	2 "	
	P. M.	39.5,	108,	5 "	Dulness in right back. Vesicular breathing. Many rhonchi.
" 14,	A. M.	38.5,	96,	4 "	
	P. M.	39.5,	104,	3 "	
" 15,	A. M.	39.0,	100,	4 "	Pulse thready. Discharge from both ears. Cognac mixture. Half a pint of red wine.
	P. M.	39.6,	108,		
	11 P. M.	40.2,			
" 16,	A. M.	39.6,	112,	3 "	
	P. M.	39.7,	100,	2 "	Musk, 0.2, every three hours.

		TEMP.	PULSE.		
March 17,	A. M.	39.1,	104,	–	stools.
	P. M.	39.0,	120,	3	"
" 18,	A. M.	39.0,	100,	3	"
	P. M.	39.6,	112,	2	"
" 19,	A. M.	39.3,	104,	2	"
	P. M.	39.6,	96,	2	"
" 20,	A. M.	38.8,	100,	2	"
	P. M.	39.6,	96,	1	"
" 21,	A. M.	39.6,	92,	–	"
	P. M.	39.4,	96,	2	"
" 22,	A. M.	38.4,	96,	2	"
	P. M.	39.8,	100,	1	"

Dulness in the right lung, and bronchial breathing from the ninth rib down.

Rhonchi in the left lung.

Crepitus in right lung, and bronchial respiration very marked. Musk continued.

Bed-sore on left nates.

Pulse better than yesterday. Patient complains of chills.

Great thirst. Many rhonchi. Brown sputa.

Stools involuntary.

The same. Much cough.

Great sensitiveness of skin. Pain in the throat, but fauces quite clear.

Much crepitus in left lung; in right lung it is heard in the middle and lower part.

One involuntary; coffee twice a day.

Examination of organs of hearing. In both external meatuses a great deal of pus, while their cutaneous coat is swollen and the outer section is excoriated. On both sides the demarcation of membrana tympani from the meatus is obliterated. Remainder of tympan-

	TEMP.	PULSE.		
				ic membrane thickened, more so in the right than in the left ear. In the right there is a pretty large central perforation, divided into two nearly equal parts by the end of the manubrium; on the left side, a large perforation in lower part; end of manubrium drawn toward the promontorium; mucous membrane of tympanic cavity swollen and pale gray. Instillation of argent. nitr., 0.6 to 30.0, followed by injection of common salt solution. Impossible to test the hearing. Was hard of hearing when admitted, and required to be addressed in a loud tone.
March 23, A. M.	38.9,	88,	3 stools.	Tongue clean; heart sounds strong; cough; much crepitus in left lung; in right lung, dulness, crepitus, and still more marked bronchial respiration.
P. M.	39.4,	96,	3 "	
" 24, A. M.	40.2,	112,	1 "	Involuntary; pulse weaker; crepitus in both lungs. In right back, dulness and bronchial breathing continue.
P. M.	39.5,	108,	3 "	One involuntary.
" 25, A. M.	38.2,	96,	3 "	Dulness of right back less marked; crepitus and bronchial respiration.

		TEMP.	PULSE.		
March 25,	P. M.	39.4,	108,	4 stools.	
" 26,	A. M.	38.0,	88,	2 "	Crepitus in both lungs behind; bronchial character of respiration persists.
	P. M.	39.3,	100,	2 "	Cough better; genuine prune-juice sputa.
" 27,	A. M.	38.1,	96,	3 "	As yesterday morning. Quiet night.
	P. M.	39.4,	112,	7 "	Very thin.
" 28,	A. M.	38.2,	96,	2 "	Much crepitus in both lungs; bronchial breathing.
	P. M.	38.5,	104,	– "	Pulse weak; champagne.
" 29,	A. M.	37.9,	88,	4 "	Much cough and expectoration during night; much crepitus in the right lung.
	P. M.	38.9,	104,	3 "	Involuntary; hoarseness so great that he can hardly be understood.
" 30,	A. M.	38.0,	96,	4 "	Two involuntary; bronchial breathing gone; much crepitus remains; much cough in the night; condition somewhat better.
	P. M.	38.5,	100,	2 "	
" 31,	A. M.	37.8,	88,	4 "	Tongue clean; much crepitus at right back; restless night.
	P. M.	38.8,	100,	2 "	
April 1,	A. M.	39.6,	96,	4 "	Two involuntary; in left back a great deal of crepitus; champagne.
	P. M.	38.0,	100,	2 "	Weak pulse.
" 2,	A. M.	37.9,	96,	4 "	Pulse better than yesterday; crepitus in both lungs.

		TEMP.	PULSE.		
April	2, P. M.	38.4,	100,	5 stools.	
"	3, A. M.	37.6,	88,	3 "	Pulse still weak ; condition as yesterday.
	P. M.	38.7,	104,	2 "	
"	4, A. M.	37.5,	100,	4 "	Large vesicular rhonchi in the right lung.
	P. M.	38.1,	104,	5 "	Pulse somewhat weaker than in morning.
"	5, A. M.	38.0,	108,	4 "	Condition as yesterday.
	P. M.	38.5,	104,	4 "	
"	6, A. M.	37.7,	96,	3 "	Great pain at seat of bed-sore.
	P. M.	38.2,	112,	4 "	Thin.
"	7, A. M.	37.2,	92,	4 "	Thin. At 10 o'clock a chill lasting fifteen minutes.
	P. M.	38.3,	108,	6 "	Thin. Lungs free, except a little crepitus at right back.
	8, A. M.	37.5,	88,	6 "	Thin. Some blood spat up in the night. Much crepitus in lungs. Ecchymoses are forming in the skin of right leg.
"	9, A. M.	38.0,	112,	4 "	Thin. Pulse very weak. Another chill. Musk, champagne. Two ice-bladders on the leg.
	P. M.	38.3,	124,	3 "	
"	10, A. M.	38.0,	138,	3 "	Thin.
	P. M.	38.6,	146,	4 "	Pulse thready. Right femoral artery still perceptible, but weaker than left.
"	11, A. M.	36.8,	130,	4 "	Pulse bad. Patient has scarcely slept, from pain in the right (thrombosed) leg. Occasional little passing chills. Pulse very

		TEMP.	PULSE.		
					weak. In the right leg the hard cord of the femoral thrombus is felt. Great weakness. The whole right leg is swollen and reddish-blue. Ice-bladders continued.
April	11, P. M.	37.2,	142,	2 stools.	
"	12, A. M.	36.6,	120,	– "	
	P. M.	36.0,	108,	4 "	Right foot begins to turn black-blue. Difficult breathing, much sweating. Pulse better than in the morning. Patient responds little when addressed; complains of headache. Evening, 11 o'clock: Great distress in breathing. Inspiration especially difficult. Patient expectorates with great effort, but abundantly. Is not at all delirious, and asks for his favorite food, potato-porridge. Death April 13, just before 1 A.M. *Post-mortem* temperature 35°. Autopsy in thirty hours.

Anatomical diagnosis.—Ileo-typhus. Purulent bronchitis, lobular deposits in both lungs, the right kidney, the liver. Perichondritis cricoidea and thyroidea. Thrombosis of the crural and the right iliac veins. Œdema of the brain and its membranes.

Examination of both petrous bones:

Right petrous bone.—In the outer meatus a great deal of pus; the cutaneous lining thickened; demarcation between inner end of meatus and membrana tympani obscured; the latter everywhere thickened, with a large central perforation, which is divided into two nearly equal halves by the lower end of the manubrium projecting into it. Mucous coat of

entire middle ear greatly thickened; much pus in the tympanic cavity and in the cells of the mastoid process. The tendon of the tensor tympani is not destroyed; it, with the ossicula, is enveloped in the hypertrophied mucous membrane. The articulation of the malleus and incus is somewhat less movable than normal, the plate of the stirrup not at all movable. Membrano-cartilaginous portion of tuba normal.

Left petrous bone.—In general the same condition as in the right, only the remains of the right tympanic membrane are less thickened than in the left, and the end of the manubrium is drawn somewhat more toward the promontorium. In the sulcus lateralis, where it forms the cover for the mastoid cells, two losses of substance, one as large as a lentil, the other of the size of a pin-head. The periosteum of the vestibule is thickened on both sides; the plate of the stapes is not only immovable, but its entire vestibular surface is equally hypertrophied.

The microscopical examination of the cochlea and the semicircular canal showed a condition of things like that of the two preceding cases.

Case 5.—Ileo-typhus. Inflammation of both tympanic membranes. Hyperæmia of the bony roof of the middle ear. Hyperæmia and catarrh of the middle ear. Infiltration of the whole labyrinth with small cells.

August Hoffmann, waiter, from Widdern, was received October 21, 1874, to the medical clinic of Professor Friedreich. He had been found that morning lying unconscious by the side of the road. The workman who brought him to the hospital said that he had uttered all sorts of disconnected words, had reached about in the air with his arms ("spasms" was the name the informant gave to these motions), and had then walked a distance with him, but without giving any information regarding his person, etc. He was taken into a private house, from which he was brought to the hospital the same afternoon.

Status præsens.—Strong body; face of natural color, not injected; hands cool, feet warm; great prostration. Temp. at 3 o'clock, 40.0; at 4, 39.0. Delirium from time to time.

At 6 o'clock, temp. 38.06, pulse 116. Replies to questions are disconnected, or are not given at all. He only gives his name, Hoffmann, in reply to questions. Strokes his hand over the coverlet. Passes urine into bed. Ordered wine by the tablespoonful. Cold affusion in a warm bath. Ice-bladder upon the head, but no distinct improvement in intelligence. The internal organs present no physical abnormity. No wound,

no signs of pain seated in any spot. Pulse not especially strong, of slight tension. Sounds of heart clear.

	TEMP.	PULSE.	
8 P. M.	39.2	—	
12 M.	39.6	—	
4 A. M.	39.4	—	Night very restless, continuous delirium, jactation.
Oct. 22, A. M.	39.4,	120,	
12 M.	39.4,	—	Thin stools, and once a quantity of urine, passed in bed. Pulse dicrotous and weak. Some questions are answered very correctly, especially after a cold affusion. Now and then slighter delirium. Dulness of spleen somewhat increased in the axillary line, no anomaly in any other organ. Tongue put out at request; is slightly coated and moist. Food is taken. Wine ordered.
4 P. M.	39.4,	—	Continuous jactation. Delirium.
6 P. M.	39.2,	124,	Occasional attempts to leave the bed. Four thin stools in bed.
10 P. M.	39.2,	—	Night very restless. Continually desires to leave the bed. Delirium. Two thin stools in bed.
" 23,	39.2,	128,	In the morning, answers questions occasionally, but in general the sensorium is very much obscured. Tongue slightly dry. Spleen slightly enlarged. No meteorism.
12 M.	39.4,	—	Sensorium continues much clouded. Answers confused, but occasionally correct. Slight increase in restlessness. Complaints of suffering and pain, which he cannot localize. Continual desire to leave the bed. Tongue as in the morning. Spleen no larger than yesterday. Pressure upon the abdomen in the ileo-coecal region seems painful. One thin stool since 9 A. M.
4 P. M.	39.2,	—	
6 P. M.	39.2,	150,	

		TEMP.	PULSE.	
Oct. 23,	10 P. M.	39.2,	——	Enuresis continues.
" 24,	2 A. M.	39.4,	——	No sleep. Raving continuous. Desire to leave bed not so strong. No stool. Urine passed in bed. Dulness over spleen 11 cm. by 7.5. Edge of spleen palpable in deep respiration. Tongue as yesterday. Urine 1,022; contains albumen, 39.0–40.0.
	12 M.	38.8,	——	One thin stool in bed.
	4 P. M.	39.2,	——	All stated symptoms worse P. M.
	6 P. M.	39.0,	——	than A. M.
	10 P. M.	39.0,	——	
" 25,		38.6,	——	Respiration 68. Consciousness al-
	2 A. M.	38.8,	——	most entirely gone since 7 o'clock.
	6 A. M.	38.6,	——	Collapse. Pulse not distinctly to be
	8 A. M.	38.6,	——	counted. Sounds of heart very weak, indistinct, obscured by the respiratory sounds. Consciousness quite gone from 11 o'clock. Sudden retardation of breathing. Death at 11.30.

Autopsy twenty-four hours later.

Anatomical Diagnosis.—Ileo-colo-typhus. Typhoid ulcers in intestine. Tumor of spleen. Cloudy swelling of liver and kidneys. Emphysema and œdema of lungs.

Roof of skull thin, but compact. Sinuses without anomaly. Pia mater and substance of brain full of blood. Ventricles of medium distention, containing clear fluid. Substance of brain hard. No other anomaly.

Examination of both petrous bones.—The bony substance of both partes petrosæ, especially the roofs of the tympanic cavities, and both antra mastoidea, are colored dark red, owing to great hyperæmia. In both external meatuses much cast-off epithelium. Both tympanic membranes are darkly injected, thick, without lustre; the parts of the malleus not visible. Right tuba not permeable; left, with difficulty. The whole mucous membrane of the middle ear of both sides is colored a uniform, strong dark red, from the ostium pharyngeale tubæ to and into the cells of the mastoid process. In the cavity of the tubæ an abundant brownish-red secretion, consisting of ciliated epithelium and fat granule cells and a few red blood corpuscles. Mucous membrane of the tympanic cavity moderately thickened. All the ossicula movable. Sheath of

facialis nerve, in its course within the tympanic cavity, is hyperæmic. But the hyperæmia is absent on both sides, both in the entire labyrinth and in both nerve-sheaths in the porus acusticus internus.

Examination of the labyrinth showed extended infiltration, with small cells on both sides; this included not only the membranous labyrinth and the semicircular canals, but also *the whole zona ossea of the cochlea.* The region of the arches of Corti and certain spots of the semicircular canals were the most affected.

Case 6.—Ileo-typhus. Recovery. Gangrene of right half of face during convalescence. Purulent inflammation in right tympanic cavity. Perforation of the tympanic membrane. Great deafness on the side affected. Infiltration of labyrinth with small cells.

S. H., a girl, æt. 16, entered the medical clinic January 18, 1873. Had rhachitis in her youth. Clinical diagnosis, typhoid. Hardness of hearing occurred only during period of somnolence, and not while she had clear consciousness. Affection of ear during convalescence. Pain in deep parts of right ear from February 17 to 21. Discharge of pus from right external meatus on 19th. Perforation of membrana in the lower forward part. Water injected passes into the throat. Watch not heard at all. Speech not understood unless loud. Death from gangrene of right half of face during the night of the 9–10th March, 1873. Autopsy, March 10.

Anatomical diagnosis.—Ileo-typhus. Bronchitis purulenta chronica. Bronchiectasia. Hypostasis. Gangrene of right side of face. Bed-sores on sacrum.

Examination of petrous bone.—Cutaneous lining of external meatus thickened, partly covered with pus; the inner end of the upper wall, also of the upper circumference of the membrana tympani, hyperæmic; boundary line between the two obliterated. Tympanic membrane in its anterior inferior part is perforated with a hole fully as large as a pea. The rest is flat and thickened. Parts of the malleus not visible. Through the perforation is seen a part of the mucous membrane of the inner wall of the drum in a state of injection, and pale red. The portion of the fauces surrounding the termination of the tuba is slightly reddened, and coated with much glassy mucus. Mucous coat of the tuba itself is injected and rose-red. The canal contains much mucus, partly in the form of small plugs, but is easily permeable to a sound of one mm. in diameter, which

could be pushed on to the antrum mastoideum. The bony roof of the tympanic cavity and of the mastoid cells is partly in a state of slight hyperæmia, partly thinned, and can very easily be removed. The mucous membrane of the tympanic cavity is hyperæmic, thickened, and has a peculiar gelatinous look. This condition extends into the cells of the mastoid process; the connective tissue which presents this appearance is infiltrated with pus-corpuscles. The joint between the malleus and incus, covered with hypertrophied mucous membrane, is easily moved. Mobility of stapes somewhat lessened. Tendon of tensor separated. Sinus lateralis unchanged. Roof of sulcus lateralis hyperæmic in some places, and in several others (of the size of a pea) it looks greenish in consequence of the presence of pus, which shines through, and in these places the bone is softened. (First stage of perforation of sulcus lateralis.) Microscopical examination of the membranous semicircular canals and sacculi shows the connective tissue which passes from the periosteum to the outer wall of these structures infiltrated with small cells, and likewise the membrana propria, which, in consequence, has mostly lost its hyaline look and its transparency.

The microscopical examination of the lamina spiralis membranacea of the cochlea shows also an infiltration of small cells, from beyond the teeth of Huschke to the outer part, but in a less degree than the membranous structures of the vestibule and the semicircular canals.

If, omitting the sixth case, in which the disease of the ear did not begin till after the typhous process had passed by, we now sum up the results of microscopical examination, we shall find that in ileo-typhus the entire labyrinth is very often affected, and on both sides. Any portion may be attacked. The parts which suffered in all the cases were the utriculus, sacculus, ampullæ, and lamina spiralis membranacea. The parts exceptionally involved were the semicircular canals and the zona osseą. The parts most essential to good hearing were regularly affected. Whether this stands in any connection with certain peculiarities in the normal distribution of blood-vessels, I cannot at present decide. Histologically, the affection is an infiltration with lymphoid cells, or a *small cell infiltration.* With the exception of a single case, in which fat granule cells were found besides the small cell infiltration, with the same anatomical distribution and in almost equal abundance, the latter was the only and the constant new formation.

Here we ought to consider how to interpret these facts. But before examining the question, we wish to contribute a few more cases of ear trouble caused by typhoid, which were only observed during life, and to add the cases of scarlet fever and smallpox.

Case 7.—Total deafness of both ears after typhoid.

P. K., æt. 17, volunteer in the train of the Seventh Prussian field Division, received March 12, 1871, in one of the barracks for epidemic diseases. According to the statement of the physician who transferred him, he had passed through typhoid fever at Dijon. During the sickness he had lost consciousness for a long time; when it returned he had lost his hearing entirely on both sides; his memory had suffered considerably, so that he could hardly give any information regarding his antecedents. This was finally obtained from his brother, who was also in the army (later in Mainz), who said that the patient had run away secretly from home to go to the war; he had never had trouble with his ears and had always been intelligent. I saw the patient twelve days after his admission, at which time he could not be examined closely, owing to a circumscribed inflammation in both meatuses. Besides this, the patient suffered at that time from pleurisy of the left side. On my return from a considerable journey, I learned that the patient had passed through a double purulent catarrh of both tympanic cavities, which was now cured. Deafness absolute as before; only for music he is said not to be absolutely deaf; he once called his comrade's attention to a hand-organ which was playing in the neighboring barrack.

At the examination, June 14, 1871, the following was noted:

Both external meatuses dry. Both membranes without lustre, their periphery very cloudy, the central part very concave, perforated by a hole as large as a pin head; handle and short process visible, without hyperæmia; posterior fold of tympanic membrane very prominently developed. Tubæ easily permeable, considerable noise indicating passage of air when air was blown in, yet without any secretion being driven out through the perforation. Nasopharyngeal space free. Absolute deafness to speech, even to the loudest shouting. The tick of a metronome is heard two inches from the ear, and (as he says) also when the instrument is placed upon the bones of the skull; the latter is the case with a watch, which ought to be heard at thirty feet, but cannot be heard by the patient at all through the air. Tuning-forks of the greatest variety of tone are said to be heard from the skull bones. I myself heard them with equal force on

both sides by means of Mach's double otoscope; in this experiment the patient said he did not hear the forks, but heard as soon as one-half of the instrument was pressed in, on the side where this was done. These experiments were repeated four days in succession with the same result. Examination by the constant current showed on both sides the formula described by Brenner as hyperæsthesia with paradox reaction, the strength being that of six Siemens-Halske elements.

Testing the patient's perception of separate musical notes gave only uncertain results, on account of the great difficulty of holding intercourse with him. I did not enter upon any treatment. By the middle of July Professor Erb had obtained no success with the constant current.

Case 8.—Total deafness of left ear after typhoid.

Joseph Kessler, Bavarian soldier of Sanitary Corps, æt. 23, always well, was received, February 28, 1870, in the hospital for epidemic diseases under the direction of Prof. Friedreich, as convalescing from a typhoid fever he had had in Corbeil. When received he was in a wretched state of emaciation, and was suffering besides from catarrhal icterus. He refers his ear troubles to the typhoid, during which he was hard of hearing in both ears; but while the hearing slowly returned to the right, the left remained deaf.

Examination of the left ear shows that the outer meatus is free, the tympanic membrane normal in every respect, the middle ear permeable. Catheterism, used for purposes of diagnosis, did not improve the hearing. Complete deafness for speech. Watch (thirty feet normal hearing distance) is not heard at all, even from the bones; tuning-fork, in several experiments, heard from the bones only in the right ear. The trial with the double otoscope showed that sound was carried with equal intensity on the well and on the diseased sides. To be discharged in two days; no treatment was begun.

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2. Inflammation of the Labyrinth in Scarlatina.

Case.—Scarlet fever. Diphtheritis of cavity of mouth and fauces. Suppuration of the cervical glands and both parotids, bursting on both sides into external auditory meatus. Acute inflammation in the cavity of tympanum on both sides. Inflammation of the labyrinth. Meningitis. Convulsions and death.

I owe the history of this case, and both petrous bones, to the kindness of Dr. Mittermaier.

Anna Sch., æt. 3, daughter of a gardener, came under treatment in the middle of February, with a severe attack of scarlet fever. The exanthema, distributed equally over the body, passed into regular desquamation. Fever at beginning, rising to 40.5° C. In the second week, temperature nearly normal, only, in the evening, a few tenths above 38°. In the third week again at 40° and over; catarrhal affection of the chest insignificant; the same with the digestive organs. Secretion of urine considerably diminished, but with a small amount of albumen. The amygdalæ and the parotids greatly swelled from the beginning. At the same time extensive diphtheritic coats in the mouth and fauces appeared. The antesterno-cleidomastoid lymphatic glands shared in the swelling. The cervical glands suppurated in spite of continued application of ice. From the cuts in both sides of the neck a great deal of ill-smelling pus flowed. The diphtherial coating in the mouth came again and again, in spite of continuous cleansing and washing out with solution of chlorate of potassa. The patient's strength fell, in spite of the administration of quinia and wine. The weakness increased, sopor supervened, and at last death was ushered in by repeated attacks of convulsions on the 12th of March.

The ear was affected before the sopor began. Very violent pains came in both ears, followed by profuse discharge, which continued until death.

Autopsy, by Prof. J. Arnold.

Body emaciated; no œdema. Both sides of throat and region of lower jaw greatly swollen, partly owing to the enlargement of cervical glands, partly to two great abscesses, through the lancet openings in which ill-smelling pus can be pressed out. Both parotids also much enlarged, especially the left. The sac of the abscess in the right submaxillary region communicates with the suppurating right parotid, and this again with the external meatus at the anterior inferior part of its wall. The abscess of the left parotid, likewise, communicates with the outer meatus at its upper wall, where the cartilaginous part passes into the bony.

A part of the squama of the temporal bone is carious and denuded of its periosteum.

Cavity of cranium.—On left side, pia and arachnoid much injected, in places cloudy and stuck together. On the surface of the left middle lobe is a small extravasation of blood. Firm thrombi in several sinuses.

In the cavity of the mouth, especially at the opening of the Stenonian ducts, diphtheritic coatings; the same in the cavity of the fauces.

Organs of chest normal. Liver and both kidneys enormously enlarged, all of a bright yellow appearance, especially upon section. Spleen swollen.

Examination of petrous bones:

Right side.—Much fluid pus in external meatus. Cutaneous lining separated from the bony wall everywhere, to the annulus tympanicus. In the anterior inferior wall of the latter, quite near to the annulus, a large defect in ossification, with jagged edge. Of the membrane of the tympanum only the manubrial portion remained. The manubrium itself was leaning against the promontorium. The tendon of the tensor tympani was separated, the incus luxated in all its articulations. The stapes remained, and was movable. Mucous membrane of the middle ear (which was full of pus) is hypertrophied.

Left petrous bone.—Cutaneous covering of temporal bone above the auricula dark-colored, and can be easily raised from the bone, to the extent of about the size of a silver half-dollar. The bony substance is discolored upon both inner and outer surfaces. Periosteum partly separated, partly destroyed. Pus between the bone and the soft parts.

In the outer meatus much fluid pus. The entire cutaneous lining is separated from the bony walls, as on the right side, as far as the annulus tympanicus. Upon the left side there is found a defect of ossification, with rough edges, at about the same point as on the right side, but somewhat larger. The membrana tympani is wholly destroyed, but the chorda tympani remains. The malleus and incus lie embedded in the mass of pus which fills the great part of the cavity. The stapes is present, and is movable. The dura mater covering the antrum is bluish, and is separated from the bone; the latter is discolored. The antrum is full of pus. Mucous membrane of middle ear hypertrophied.

Microscopical examination of the labyrinth gave similar results on both sides.

The membranous sacculi, and the membranous semicircular canals, were more adherent than normal, owing to proliferation of the connective tissue between the periosteum of their bony walls and the membrana propria; the connective tissue itself more vascular, with abundant infiltration of small, round cells, or of pus cells. Both these kinds of infiltration extend in such abundance over the membranous sacculi, the ampullæ, and the membranous semicircular canals, that their membrana propria is nowhere plainly visible. On the lamina spiralis membranacea of the cochlea this was so much the case that the separate regions of the finer structures could hardly be distinguished from each other.

It has long been known that the pathological changes of the organ of hearing which occur as concomitant phenomena of infectious diseases, and especially of the acute exanthemata, are most extensive and severe in the case of scarlet fever. In fact, if we look at the pathological changes found in both petrous bones, the amount of destruction must seem quite extraordinary; whether it were assisted by transference of diseased processes from the parotis to the external meatus, or, on the other hand, probably—I could not examine the condition of the tubæ myself—by transference of inflammation from the diseased fauces to the middle ear. All parts of the organ of hearing were attacked, even the squama of the left temporal bone. This is simply a universal inflammation of all the tissues of the organ, like panophthalmitis.

The state of things found in the labyrinth may serve to explain all those cases of severe or complete deafness after scarlatina, in which the analysis of the other clinical symptoms absolutely forbids the supposition of a cerebral affection as the cause of the disturbances of hearing. Such cases have often met my notice, and probably have often been observed by my fellow specialists.

The meningitis was secondary, and either originated in the ostitis of the left temporal bone, or was assisted to spread by the numerous fibres of connective tissue found in a child's petrous bone passing from the dura mater into the middle ear; or both may have been the case.

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3. Purulent Inflammation of the Labyrinth in Variola.

In a child of four years, which died in the smallpox department in this town, during the suppurating period of the disease, I found the following in both petrous bones:

In both external meatuses a great deal of pus. Tympanic membranes mostly absent. Manubrium mallei drawn toward the promontorium. Connection between incus and stapes luxated. Stapes remains, and is movable. Tendon of tensor separated. Mucous membrane of the

tympanic cavity slightly hypertrophied; cavity full of pus. Semicircular canals, ampullæ, and sacculi appear to simple inspection thicker than normal, and of a citron yellow.

Microscopical examination shows an abundant formation of connective tissue between the bony and the membranous labyrinth.. The single threads of connective tissue are infiltrated with numerous pus cells. Numerous pus cells in the sacculi, still more on the semicircular canals and the ampullæ. The zona ossea and membranacea of the convolutions of both cochleæ are plentifully covered with pus cells, some single, some grouped. The blood-vessels of the lamina spiralis membranacea are very full.

Microscopical examination shows the nerves in the meatus auditorius internus intact.

The case is one of purulent inflammation of the middle and inner ear. The former is universally known as a concomitant phenomenon of variola vera; the latter has hitherto escaped observation, but may very likely be common enough, for the examination of the labyrinth in the case of persons dead of variola has hitherto been neglected. Unfortunately, I have as yet had only this single opportunity. But, now that attention has once been called to it, I doubt not that the number of such cases will increase. It is probably the case of a purulent inflammation of the labyrinth accompanying the general disease. The state of things found is quite like that in cases of inflammation of the labyrinth accompanying meningitis cerebralis, but with this distinction: that in the latter the affection of the labyrinth may either develop spontaneously and simultaneously with the changes in the membranes of the brain and cord, or may follow the course of the neurilemma, press into the labyrinth, and appear as a secondary affection. (Comp. A. Heller. Zur anatomischen Begründung der Gehörsstörungen bei Meningitis cerebr. spinalis. *Deutsches Archiv f. Klin. Med., III.*, p. 482.

This pathologico-anatomical condition very probably explains the functional disturbances which I have observed in the following case:

R. T., æt. 4, was brought to me by his father, November 4, 1873. The latter stated that the child had heard well to the end of its second year,

and had spoken. At that time it thrust a bean into its right nostril. As the attending physician could not discover the bean, he injected cold water by means of Weber's nasal douche. The foreign body did not come to light, but violent pain in both ears followed, and soon after purulent discharge. After some time the latter ceased wholly; the hearing was weakened, but neither this nor the power of speaking were lost.

Three months ago the child was attacked with variola vera, of which it has retained very strong traces in the face. From this time its hearing gradually grew weaker, to the point of complete extinction; the child's stock of words also diminished rapidly. I found absolute deafness.

The tympanic membranes showed marks of a previous otitis media purulenta, namely, a scar on the right side, a perforation on the left.

It now remains for us to decide the problem, how the histological changes found in the labyrinth of typhoid patients can be explained from the point of view of general pathology; whether we have to do with,

1. A specific new formation, special to typhoid; or with,
2. A simple state of irritation—an inflammation.

1. The following reasons may be given for the assumption of a specific new formation peculiar to typhoid. In the first place, the uniformity with which the affection occupied both sides, even in the fifth case, where (see the reports of autopsy) it is impossible to speak of any transference of the morbid process from the middle to the inner ear. Besides, we ought to consider the resemblance borne by these processes to changes occurring in other organs during typhoid, such as have been observed, not only in the glands of the intestinal mucous membrane, and in the mesentery, but also in the liver, the kidneys, and on the peritoneum, by E. Wagner,* Friedreich,† and others.

Not only might the small cell infiltration be so interpreted, but also the fat granule cells described in the first case, which can be taken as a sign of commencing caseation, as well as of incipient resorption.

* Comp. E. Wagner; Beitrag zur pathol. Anatomie der Leber beim Abdominaltyphus. Archiv der Heilkunde, 1860, p. 322 *et seq.*

† Friedreich, Virchow's Arch., Bd. XII., p. 53.

2. It might be assumed that in the first four cases, where there was also a purulent inflammation of the tympanic cavity, the inflammation was simply propagated from the tympanic cavity through the wall of the labyrinth to the cutaneous labyrinth, especially as the membranous tissues of the vestibule lying next the tympanic cavity were often the most seriously affected (even the periosteum of the vestibule being attacked in some cases); and besides, the changes in the labyrinth did not differ in any respect from those of the first stage of inflammation. The state of the labyrinth could be accounted for in like manner in the case of scarlatina. Moreover, the specific character of the changes in the labyrinth can be denied, for in the sixth case the typhus process had already completed its course; I myself lately published a case of caries of the temporal bone,* in which it is impossible to admit any specific character to the exudation, but which presented the same order of changes in the labyrinth.

Clinical reasons may be brought to support the view that the inflammation is transplanted from the tympanic cavity. I have had a variety of chronic cases of purulent inflammation of this cavity, originating in a purely local process without constitutional disease, in which the functional tests—absence of conduction of watch sound and tuning-fork through the bones, extremely poor perception of speech—caused me to diagnosticate an affection of the labyrinth, with an unfavorable prognosis; but which, under exclusively local treatment, continued to improve, the affection of the middle ear passing away, and the conduction of sounds of watch and fork, as well as the perception of speech, returning gradually at the same time. Such cases can hardly be explained except by assuming that simultaneously with the alterations in the middle ear, and caused by them, an inflammatory product similar to what has been described exists in the labyrinth, which is gradually reabsorbed, along with the improvement in the affection of the middle ear.

But, even if we regard the inflammation in the labyrinth as propagated from the tympanic cavity, it still remains possible

* Pathological Anatomy of Ear. Case IV. These Archives, Vol. III., No. 2, p. 183.

that the affection of the middle ear itself stands in a relation of cause and effect to the typhoid process. Catarrhal affections of the mucous membranes in general are not rare occurrences in typhoid. If it is objected that the changes described are in no way to be distinguished from those of ordinary cases of purulent inflammation of the middle ear, it is proper, on the other hand, to repeat the affirmation that the changes occurring in the other mucous membranes in typhoid, as those of the pharynx and bronchi, are open to the same objection. The latter are often limited to a simple catarrhal affection, while in the larynx not only this, but also diphtheritic and croupous affections and even specific typhoid ulcerations occur. The case is similar as to the mucous membrane of the middle ear in typhoid. In one series of cases, nothing more than a simple catarrh of the Eustachian tube and the tympanic cavity occurs (Griesinger, Schwartze); in another series this goes on further, to the development of purulent inflammation of the latter and its consequences (Schwartze, Hoffmann, original observations).

For the present I will content myself with having stated the various possible methods of explanation, and pointed out the fact that inflammations in the labyrinth are very common in typhoid patients; I hope that at some future time I or some colleague will succeed in bringing sufficient evidence from facts, to decide whether in such cases we have to do with a specific typhoid process or not.

Nevertheless, in the interest of the clinical interpretation of the disease, especially in non-fatal cases, I consider that we are already entitled to describe the various possible modes of termination of the labyrinth affection, whatever may be the result of later investigations. If the affection be an inflammatory irritation, the latter may increase in its course to a purulent inflammation, as is described in the cases of scarlatina and smallpox here given; or a fatty breaking down and complete resorption of the exudation may occur; the latter may be the case, even when we have a typhoid new formation, or there are opacities, thickenings, or atrophy of the affected tissues; or, as in the intestinal follicles and the mesenteric glands in typhus, there may be necrosis or ulceration.

In applying these various possible results to those disturbances of hearing accompanying typhoid, which offer only negative symptoms during life, we may expect to find:

1. Gradual and spontaneous disappearance of functional disturbance of hearing; or

2. Persistence of some degree of deafness, with or without subjective noises; or

3. Complete unilateral or bilateral destruction of function.

MANOMETRIC CICATRIX OF THE MEMBRANA TYMPANI.

By CLARENCE J. BLAKE, M. D., Boston.

In a paper published in the Transactions of the American Otological Society for 1875, a case of movable cicatrix of the membrana tympani was reported: the character of the movements of the cicatrix, the conditions under which these movements occurred, and the results of the tests to which these conditions were subjected, proving conclusively varying degrees of intra-tympanic pressure during natural respiration and during phonation, which could be explained only by assuming a persistent patency of the Eustachian tube.

A second case, presenting substantially the same symptoms, and affording an opportunity for the repetition of the previous experiments, having fortunately come under recent observation, is made the subject of this paper.

The patient, a girl eighteen years of age, had suffered from purulent inflammation of the right middle ear in childhood. The inflammation and otorrhœa finally subsided, leaving a considerable diminution of hearing, and the following condition of the middle ear: The external auditory canal was normal, the membrana tympani exhibited a large perforation, fully two-thirds of the membrane having been destroyed. This perforation included principally the anterior and inferior segments. The remaining portion of the membrana tympani was much thickened, opaque, and showed two or three small spots of calcareous deposit. The malleus was drawn inward by the retraction of the musculus tensor tympani, the end of the manubrium being in contact with the inner tympanic wall. From the anterior edge of the perforation a cicatrix extended inward to the inner tympanic wall, and also upward and downward; extending, therefore, across the opening of the Eustachian tube, and completely separating the anterior from the posterior portion of the tympanic cavity. This cicatrix was consequently in the position best fitted to enable it to respond

to any pressure exerted upon its inner surface through the Eustachian tube, a condition almost precisely similar to that occurring in the case previously reported. The patient complained of a disagreeable sensation in the right ear, of about one week's duration, and following a severe head cold, during which it had been necessary to blow the nose forcibly and frequently. This sensation occurred with each expiration and inspiration, and on coughing or blowing the nose, and was described as a feeling of movement in the ear. It was also noticeable, but very slightly, and on attention being called to it, on the sounding of *m*, *n*, and *ng*. Examination showed during expiration a movement of the cicatrix outward, with a corresponding movement inward during inspiration. This movement was much more decided when the patient breathed through the nose, and less marked on breathing through the mouth. Valsalvian inflation forced the cicatrix outward, its centre being nearly on a level with the anterior edge of the perforation of the membrana tympani.

During phonation the movements of the cicatrix corresponded to those observed in the previous case, and to the logographic curves of the consonant sounds, as nearly as this could be determined by measuring the extent and duration of the excursions of the cicatrix.

With the *m*, *n*, and *ng* sounds, either pronounced separately or following in the course of conversation, the movements were most decided, and the excursions of the cicatrix were increased in extent by closing the nostrils while speaking. A repetition of the experiments made in the first case, and an observation of the movements of the cicatrix, showed the pressure in the naso-pharyngeal space, and consequently the intratympanic pressure, to be greater during the sounding of vowels followed by the consonant checks, and as a rule, less when the consonant preceded the vowel sound. With *m*, *n*, and *ng*, as has been stated, the movement was greatest; and with the pure vowel sounds little or no movement was perceptible.

The patient was fortunately willing to endure the sensations in the ear for the sake of experiment, and after a repetition of the tests on succeeding days, the cicatrix was punctured, with relief from the disagreeable symptoms, which have not returned during a period of three months.

The occurrence of these sensations in the ear on breathing and during phonation, at so late a day, and so long after the probable completion of the cicatricial growth, may be explained on the supposition that an originally tense cicatrix had become gradually stretched and extended inward, by the forcible infla-

tion of the Eustachian tube during successive head colds, the result being, in both of these cases, the furnishing of a delicate manometric membrane, so circumstanced, both as to its position and its laxity, as to respond readily to very slight pressure. The delicacy of this natural manometer was readily shown, by comparing its movements with those of a column of fluid in a Politzer manometer inserted in the ear after puncture of the membrane; the pronunciation of the softer consonant sounds causing a movement of the cicatrix which could not be detected in a fluid column one mm. in diameter and two cm. in height.

OTOLOGICAL REVIEW.

By CLARENCE J. BLAKE, of Boston.

1. C. Böters. Ueber Necrose des Gehör-Labyrinths. Inaugural-Dissertation. Halle, 1875.

2. A. Lucæ. Ueber Ausstossung der nekrotischen Schnecke mit Bemerkungen über den relativen Werth der üblichen Methode der Hörprüfung. *Arch. für Ohrenheilkunde,* B. 13. IV.—4.

3. Darolles. Otite aiguë moyenne, paralysie faciale et méningite aiguë par irruption du pus dans l'aquéduc de Fallope. *Bullet. de la Societé Anat. de Paris.* 1875. 1.

4. M. E. Tourneret. Infection purulente suite d'otite interne. *Gaz. Méd. de Strasbourg.* 1875. 2.

5. R. Voltolini. Die acute Zellenhautentzündung in der Supra-und Postauricular-Gegend. *Monatschr. für Ohrenheilkunde.* Dec., 1875.

6. F. Oyston. Memorandum of the Presence of Air in the Middle Ear as a sign of Live Birth. *Br. and Foreign Med. Chirurg. Review.* Oct., 1875.

7. J. Luys. Contributions à l'étude des lésions intra-cérébrales de la surdi-mutité. *Annales des Maladies de l'Oreille et du Larynx.* 1. 5.

8. Charcot. Guérison de la maladie de Ménière par le sulfate de quinine. *Gaz. des Hop.,* 1875. 95–98.

9. B. Hagen. Subcutane Injectionen von Strychninum nitricum gegen nervöse Schwerhörigkeit und Innervationsstörungen der Binnenmuskeln des Mittel-Ohrs. *Centralbl. f. Med. Wissenschaften.* 1875. 36.

10. J. J. Itard. L'électrothélerapie appliquée aux bourdonnements d'oreille et à la surdité nerveuse. *Thèse de Paris,* 1875.

11. V. Vajda. Syphilitische Infection der Tuba Eustachii. *Bericht der Klinik fur Syphilis des K. K. Allgemeinen Krankenhauses.* Wien, 1875.

1. Jacoby, in his review of Dr. Böters' paper, says with justice that among the numerous otological inaugural dissertations which have from time to time proceeded from the medical school of Halle, this is especially worthy of notice. The author gives a very comprehensive review of the literature of the subject, and draws his conclusions from these and from his own observations with commendable clearness. The introduction, which directs attention to the fact that in consequence of anatomical stric-

ture necrosis can occur only, with exception of the external auditory canal, in the osseous labyrinth, enumerates chronologically, with commentary notes, the cases of necrosis of the labyrinth, accompanied by descriptions of the osseous preparations, which have been recorded since the first paper of Wilde in 1855. In all the sixteen cases given, with exception of that reported by Dr. Canells (Glasgow), there was absolute deafness, and in seven of these also facial paralysis.

This table is followed by a discussion concerning the relatively rare occurrence of necrosis as compared with caries, and of the influence which age, sex, and general constitutional condition may have in this connection.

As immediate cause of the pathological process in the osseous structures of the labyrinth there existed in all the cases, with the exception of that of Wilde, a purulent inflammation of the mucous lining of the tympanic cavity, with periostitis of the petrous portion of the temporal bone, of several years' duration. In support of the occurrence of necrosis of the labyrinth as a more or less isolated affection, the author cites the notes of v. Tröltsch in this connection, namely, the early and complete ossification of the labyrinth, its nourishment by means of especial non-anastomosing vessels, and finally, its extraordinary solidity of structure. The frequent coincidence of facial paralysis with necrosis of the labyrinth, occurring in seven of the sixteen cases, the author refers to the topographical relations of the outer and superior semicircular canals and cochlea to the Fallopian canal, which would render a necrotic separation of any of these structures without injury to the canal and the facial nerve out of the question—an opinion which is fully supported by the pathological observations in cases given.

As an explanation of the existence of a necrosis of the labyrinth without implication of the surrounding spongy bone, the author presents two possibilities, namely, embolism of the internal auditory artery, which probably existed in the case of Wilde, where the necrosis was not preceded by a purulent inflammation of the middle ear, and purulent periostitis of the labyrinth as a result of chronic purulent inflammation of the middle ear, the means of communication being afforded by destruction of the membrana tympani secundaria; numerous *post-mortems* in such cases showing the course of the disease, which terminated fatally before complete necrosis of the labyrinth occurred.

A further proof of the correctness of this assumption is found in the presence of polypi accompanying the chronic purulent inflammation of the middle ear in the majority of the cases, with the consequent retention of the foul secretions and increased pressure. In this connection the author

directs attention to the comparative immunity from the pathological process possessed by the semicircular canals, and finds in the comparatively frequent implication of the cochlea alone an evidence of the correctness of the assumption that the fenestra rotunda serves as the channel for communication of the purulent periostitis to the labyrinth, for did this occur by means of a fistulous opening into the semicircular canals or through the fenestra ovalis, observations would not be wanting of separation of the semicircular canals alone. As symptoms of the rupture of the membrana tympani secundaria and the extension of the purulent periostitis, the most characteristic are the sudden occurrence of loud, subjective noises, deep-seated pain, vertigo, nausea, and vomiting. Following the enumeration of symptoms, the author gives notes as to the duration of the disease in the several cases mentioned, from the first implication of the labyrinth to the time of its separation—in some cases until removal of the necrosed cochlea. The thesis concludes with a review of the prognosis and treatment of this comparatively rare complication of middle-ear disease.

2. In connection with the above thesis a case recently reported by Prof. Lucæ is of especial interest. The patient, a strong, healthy man, dated his affection of the right ear from the year 1866, when, during artillery practice, following the discharge of a field piece, he noticed a sharp pain in the ear followed by a slight hemorrhage; with exception of deafness he had no further symptoms of trouble for several years, until, in October, 1874, there appeared a purulent, sanguineous discharge from the ear accompanied by a chronic headache confined to the right side of the head, and frequent vertigo, which finally led him to seek relief at the hands of the author in May, 1875. At this time the whole of the right auricular region, both in front of the tragus and over the mastoid process, was slightly tender on pressure and percussion; no swelling, however, was visible. The external auditory canal was swollen and filled with offensive pus, removal of which revealed deep-seated granulations. The left ear being tightly stopped, words whispered close to the right ear were distinctly heard. Ordered syringing with salycilic acid (1 : 600). Four days later canal and anterior auricular region swollen; wet compresses were applied for seven days, with diminution of the pain, tenderness, and swelling; at this time pressure upon the mastoid region gave little or no pain, and an examination following thorough syringing of the ear revealed in the cartilaginous portion of the external auditory canal a hard body of a dirty, grayish color and about the size of a pea. This was removed with the forceps, and proved to be the upper two-thirds of the necrosed cochlea. A repetition of the tests for hearing gave the following results: The left ear being tightly stopped,

whispered words were heard, as on the occasion of the first examination; but on the right ear also being closed, the whisper was heard with equal distinctness. The same result was given by tests with König's rods.

The tests of conduction of sound through the bones of the head are especially noteworthy. The large tuning-forks C′, C, and contra-A, applied to the apex and on the forehead, were heard only in the left, the unaffected ear, but applied to the occiput equally well in both ears. The large C fork being applied to the right mastoid, the patient was uncertain as to whether the sound was heard only on the right or also on the left. The butt of the fork being placed in the right meatus, the patient merely felt the vibration without hearing the tone.

Nine days later the meatus was but slightly swollen anteriorly and superiorly, the granulations and discharge had nearly disappeared, the opening in the anterior portion of the membrana tympani was plainly visible, the headache and vertigo had entirely disappeared, and the patient passed from observation. Four months later his condition remained the same, and there had been no recurrence of the otorrhœa.

This case is interesting from the original cause of the trouble and the later occurrence of the more serious disease, the comparative immunity of the patient from the graver symptoms which might have been expected, and the progress of the ultimate necrosis to so favorable a result. It demands further consideration also from the results of the tests with regard to the hearing, upon which Prof. Lucæ lays particular stress. The apparent perceptive power remaining to the affected ear is in itself a sufficient commentary upon the necessity for careful tests in comparative cases, the degree of sound conductibility, not only of the ear itself, under pathological conditions, but also of the circumjacent parts, being an open question.

3. The case reported by Darolles is a sufficient commentary upon itself, and may be quoted as presenting the course of the disease without surgical interference. A woman thirty-eight years of age, having caught a severe cold after an attack of acute rheumatism, had severe pain and almost total deafness of the right ear. Three days later she complained of a sensation as if the drumhead had been ruptured, and with the appearance of a purulent discharge the pain diminished ; the deafness, however, persisted. Two days later, recurrence of cephalalgia, the purulent discharge diminished, and there was tenderness on pressure over the mastoid. On the tenth day from the commencement of the inflammation complete facial paralysis on the right side, and from this time forward marked fever and obstinate constipation. On the thirteenth day contraction of the muscles of the neck, pulse 130, temp. 40.8°. On the fifteenth day, opisthotonus,

herpetic eruption of the face—on the right side about the lips and angle of the eye, and on the left side in the centre of the cheek. On the sixteenth day, profuse perspiration, involuntary evacuations, and paralysis of the left arm; pupils dilated, and reacting slowly; thready pulse, and a temperature of 40.6°. In the evening the patient died. The section showed injection of the veins of the pia and dura mater, extensive purulent infiltration of the subarachnoid cellular tissue, especially at the base, and also on the convexity of the right hemisphere; on the left side only that portion of the brain over the sphenoid. Small, insulated collections of pus were also apparent along the course of the blood-vessels on the convexity of the brain; in several places the pia mater was adherent to the gray substance. The outer surface of the petrous portion of the temporal bone was intact, the tympanum filled with pus, in which the ossicula floated free. In the superior portion of the membrana tympani was a small perforation; the mastoid cells were also filled with pus, and the facial nerve, laid bare to the point at which in the hiatus Fallopii it makes its second turn, was covered with thick pus; the remaining walls of the tympanic cavity were intact.

4. The following case may be added to that above quoted:

A female teacher, forty-three years of age, never very robust, and having scrofulous scars on the neck, was attacked, after taking cold, with severe intermittent pains in the right side of the head. These symptoms were followed by perforation of the membrana tympani and purulent otorrhœa, and later still by cessation of the purulent discharge, marked chills, and constipation. Three weeks later the cephalalgia diminished coincidently with the occurrence of severe pain in the left hypochondrium and decided fever, the pupils became dilated, the conjunctiva assumed a yellowish tinge, the tongue became heavily coated, the pulse dicrotic, the temperature rose to 40.2°, and delirium set in. The abdomen became tender, there were marked icterus and involuntary evacuations, the pulse could be barely felt, the temperature suddenly fell to 36°, and the patient died four weeks from the commencement of the attack. The section gave: hyperæmia of the dura mater, especially on the right side; pseudo-membranous deposits on the arachnoid; the substance of the brain and the ventricles intact; the outer surface of the temporal bone showed no signs of caries, but no thorough examination was made. The spleen was swollen and softened, with *metastatic abscesses;* the kidneys hyperæmic, and in the right kidney two *metastatic abscesses.* There was also fresh peritonitis, and numerous submucous ecchymoses in the intestine.

5. Voltolini directs attention to a form of mastoid periostitis as yet

undescribed by otological authorities. Slight mention of independent periostitis of the mastoid is made by Wilde, and also by Gruber,* and it has been the fortune of the reviewer to have observed one case in which the acute periostitis of the outer surface of the mastoid was hardly referable to any extensive inflammatory process from the meatus or middle ear. The ætiology of the ordinary mastoid periostitis has been so carefully studied and so richly illustrated during the past few years, that the first question which occurs to the reader of this paper is concerning the possible origin of an inflammation of so severe a character, independent of any previous inflammation of either the outer or middle ear. Voltolini considers the disease described as much peculiar to the mastoid region as is the othaematoma peculiar to the auricle, and as regards its ætiology, remarks that he has observed such cases in Silesia only, although, as is well known, he has had control of ample otological material previously in the far north, in Pomerania and in Berlin. The disease appears to result from atmospheric causes, that is, from exposure to cold ; at least, this was the explanation given by several of the patients. The region implicated also is that portion of the post-auricular surface free from hair and particularly exposed, and what is further characteristic, not only one side but the corresponding region behind both ears was sometimes similarly affected.

The ear itself remains intact, but may sometimes in the course of the disease participate in the inflammation. The disease begins with severe tearing pains on one or both sides of the head, which extend to the side of the face and teeth. The pain is sometimes referred to carious teeth by the patient, but later, fever sets in, and the pain becomes localized about the posterior auricular region, the mastoid surface becomes swollen, smooth, red, tense, and exceedingly tender. If active antiphlogistic treatment does not relieve these symptoms, the case progresses to suppuration, under which circumstance the best remedy is, as always, the knife. The same rule with regard to the early use of the knife holds good in these cases, as in those where the superficial periostitis follows an acute inflammation of the middle ear. The following cases may be cited in illustration : A shepherd, forty years of age, was attacked after exposure with severe pain, swelling, redness, and tenderness above and behind the right ear ; the application of eight leeches did not diminish these symptoms, and on the following day a long and deep incision was made over the mastoid. The pain was almost immediately relieved, the patient slept well, and made a good and speedy recovery.

* Oster. Zeitschr, für Prakt. Heilkunde, 1863.

A woman, forty years of age, after exposure in the open air with the head uncovered, had severe pain in the left side of the head, which finally became confined to the region of the mastoid. The hearing being somewhat diminished, the patient was at first treated by the family physician for a supposed disease of the ear. The author, being called in consultation, found the following condition : The region behind and above the ear was swollen, red, and tender ; with exception of a slight swelling on the superior posterior wall of the external auditory canal, the outer ear was normal. The membrana tympani, although there was some diminution of hearing, presented no specially abnormal appearance, nor was there any evidence of more deeply seated trouble. Three days later, after application of poultices, an incision was made above and behind the ear, with liberation of considerable foul pus, and a relief from the pain, which continued to the termination of the case in recovery. The third case given did not end so fortunately,

A gardener, fifty-six years of age, in the winter of 1874, rode a mile into the country in an open wagon, a cold wind and snow blowing upon the back of his head. On the following day he was attacked with severe pain affecting the whole head and teeth. This pain continued with varying intensity, but always severe, for several weeks, and finally became localized behind both ears. The mastoid region became swollen, and the proposal for an incision, made by the physician called in attendance, being refused by the patient, the inflammation took its course. The application of poultices finally induced a spontaneous opening and discharge, with some relief from the pain, which still continued in a measure. Nine months after the first attack the patient was seen accidentally by the author, who found the following condition : The hearing was but slightly diminished, as the patient could easily hear conversation in the ordinary tone. The region behind and above both ears was much swollen and relaxed, pus discharged from the left ear having found its way through the posterior wall of the meatus. Fistulous openings in the neck led upward to the original seat of the inflammatory process, the pus having burrowed on both sides for a distance of from two to three inches before finding escape.

Free incisions, opening up the channels through which the pus had burrowed, were made, but a careful examination failed to detect any implication of the bone ; this treatment, followed by poultices, seemed of good effect, and the patient improved with nourishing food and rest. On the third day fever set in, with increased weakness, erysipelatous inflammation attacked the edges of the cuts, and then extended over the scalp, and, on the ninth day after the operation, the patient died.

A study of these cases shows that the disease is neither one of the auricle, the external auditory canal, the tympanic cavity, nor the mastoid cells; that it originates without, and not within the ear, and that it may progress inward, but would hardly penetrate deeply. As has been before said, the rule with regard to incision holds good here, as in those cases where the inflammation follows the periosteum along the posterior wall of the auditory canal, the original seat of the disease existing in the middle ear.

The case observed by the reviewer as presenting somewhat similar symptoms, was that of a young woman, twenty-six years of age, recovering with great prostration from typhoid fever. Earlier in the disease there had been purulent inflammation of both middle ears, with large perforation of the membrana tympani of both ears. This disease was rapidly diminishing, and the purulent discharge had gradually decreased. Severe headache, lasting several days, was followed by localization of the pain behind and above the left ear. There was no accompanying change in the quantity or character of the otorrhœa, such as would have accompanied an extension of the inflammation to the mastoid cells; the constitutional symptoms, notably the premonitory increase in temperature, were also wanting, and there was neither redness, tenderness, nor swelling of the external auditory canal. The tenderness over the mastoid region, also, was general, as in external mastoid periotitis, and not localized, as in inflammation of the mastoid cells. The case was remarked particularly at the time for the peculiarity of its symptoms; and, considering the general condition of the convalescent, and the liability to superficial abscesses in such cases of debility, the diagnosis of independent periostitis of the mastoid region was given. The treatment consisted in the application of poultices, and a free incision, liberating about an ounce of pus, with relief from the pain, and recovery in two weeks. During this time, the disease of the middle ear remained unchanged, and is now following its usual course toward recovery.

6. In a paper published in the Monatschrift für Ohrenheilkunde, in 1868, and in subsequent papers, some of which have appeared quite recently, Wreden has directed the attention of medical jurists to the entrance of air into the middle ear, and the disappearance of the gelatinous substance which fills the tympanic cavity prior and up to the birth of the child. These communications, in which the author claims for this test an equality to, if not an advantage over the ordinary test, by examination of the lungs, have called forth considerable testimony in rebuttal, and among the papers published both in Germany and England is an interest-

ing table given by Ogston. Wreden states that the gelatinous substance mentioned disappears within twenty-four hours after birth; that twelve hours' respiration is not sufficient to effect its complete disappearance; and he therefore suggests that the occurrence of the presence of air in this situation might be of importance in a medico-legal point of view, as proving that respiration had taken place. Ogston, on the other hand, considers that these statements have been made without sufficient grounds, and that they require considerable modification. In support of this opinion he submits the following table of fifteen cases:

	AGE.	STATE OF MIDDLE EARS.	STATE OF LUNGS.	CAUSE OF DEATH.	OTHER FACTS TO FIX TERM OF LIFE.
1	14 weeks.	Filled with air.	Fully expanded.	Smothering.	Bronchitis.
2	9 weeks.	Filled with air.	Fully expanded.	Smothering.	Bronchitis.
3	2 months.	Filled with fluid.	Fully expanded.	Smothering.	
4	6 weeks.	R. air. L. muddy fluid.	Fully expanded.	Smothering.	Bronchitis.
5	1 month.	Filled with air.	Fully expanded.	Smothering.	
6	4 weeks.	R. air. L. air and fluid.	Fully expanded.	Broncho-pneumonia.	
7	8 days.	Filled with air.	Fully expanded.	Bronchitis.	Lungs bulky, emphysematous.
8	3 days.	Containing air.	Fully expanded.	Smothering.	
9	2 hours.	Fluid and yellow substance.	Partly expanded.	Apoplexia neonatorum.	Breathed feebly two hours.
10	New-born.	Containing fluid.	Expanded.	Smothering.	Meconium in large intestine.
11	New-born.	Filled with red fluid.	Expanded.	Fracture skull.	Meconium in large intestine.
12	New-born.	Containing fluid.	Expanded.	Smothering.	Navel string attached.
13	New-born.	Containing red fluid.	Partly expanded.	Query.	Navel string attached.
14	New-born.	Containing air.	Expanded.	Smothering.	Navel string attached.
15	New-born.	Containing fluid.	Unexpanded.	Still-born.	

The first six cases might have been omitted from the table in this connection. The last nine, says Prof. Ogston, are those in which Wreden's proposed test would be supposed to be useful, but in only three (6, 7, 14) was air found in the middle ears, although the lungs in all, with exception of a still-born, immature infant, contained sufficient air to float in water, and from all air could be expressed when held under water.

7. Luys gives the results of careful *post-mortem* examinations in two cases of deaf-mutism of long standing, and finds in his microscopic sec-

tions ground for the opinion which his paper sets forth, that the intracerebral point for the transformation of the sensation of sound lies in the posterior portions of the thalami optici, while the ultimate point of perception is to be found in the posterior region of the cortical substance. In both of the cases examined the posterior portion of the thalamus opticus was of a grayish color, softened, with serous infiltration resembling a colloid substance, and exhibiting a large number of amyloid bodies. The gray substance in the neighborhood of the aqueductus Sylvii was changed in the same manner. The continuations of the nervi acustici in the fourth ventricle were visible in the form of indistinct, greyish, œdematus fibrils.

8. Charcot, having observed, in several cases, that the attacks which occur during the progress of Ménière's disease were preceded by a loud whistling subjective noise, and that, like the aura epileptica, this was the premonitory symptom of the vertigo, loss of co-ordination of motion, nausea, and vómiting which quickly followed, was led to attempt the substitution of a similar physiological symptom by means of quinine, thereby aborting the subsequent attack. In several cases which, according to Revillout, presented the group of symptoms characteristic of the so-called Ménière's disease, Charcot gave from 0.75 to 1.20 grm. sulphate of quinine daily continuously for several weeks. The subjective sound resulting from the quinine was kept up for several weeks at a time, and the remedy was omitted occasionally only, in case of disturbance of digestion, and then resumed. In a majority of the cases a decided improvement was effected, and in some, so far as the attacks mentioned were concerned, complete relief followed. Whether that marked symptom of the disease, the deafness, was also relieved, the paper does not state. In a later number of the same journal Dr. Barcot gives the results of the administration of quinine in similar cases, with equally good effect.

9. Hagen reports the results of his use for the past nine months of subcutaneous injections of strychnine in cases of nervous deafness. He finds this treatment of unquestionable value and of permanent effect. An aqueous solution of one per cent. is used every third day, and injected under the skin, covering the mastoid process. In the cases in question, little or no other treatment was employed. The injections of strychnine seemed to have no effect whatever upon the subjective symptoms.

10. Following a description of the various forms of apparatus for the application of electricity and for testing its effects upon the human system, J. J. Itard takes up the question of tinnitus aurium, and divides this affection, according to its causes, into five different classes:

1. Tinnitus due to the presence of a foreign body in the external auditory canal or Eustachian tube.

2. Tinnitus due to inflammation of some one of the divisions of the organ of hearing.

3. Tinnitus of vascular origin.

4. Tinnitus of nervous origin.

5. Tinnitus occurring without appreciable pathological change, and the origin of which is questionable.

The results, as given, of his observations on the use of the galvanic current, the rheophores being applied over both mastoid processes, may be summed as follows:

1. The currents modify and localize the tinnitus.

2. Certain subjective sounds resist the action of the current longer than others; this is especially the case with a whistling sound.

3. The tinnitus diminishes in intensity with the diminution of the deafness, and disappears with the restoration of hearing.

4. The use of the galvanic current is sufficient to cure deafness of nervous origin; if this result is not obtained, at least, the hearing is always improved.

5. A shorter period is necessary for treatment if the deafness is of recent origin.

6. A degree of relief is experienced immediately after the application of the current.

7. Only feeble, continued currents should be used.

8. It is important not to fatigue the patient by too prolonged or too painful an application.

9. The more simple operative procedures give the best results.

The breadth of the conclusions as above given lays them open to criticism on that account, and as regards the third statement, that the subjective noises become more feeble as the deafness diminishes. The reviewer's experience has been that in a large number of cases the negative pole being applied to the affected ear, the tinnitus increased with a progressive improvement in hearing, and then diminished, sometimes quite rapidly, the improvement in hearing continuing.

11. Dr. Vajda reports an interesting case of syphilitic infection which, his conclusions being correct, carries its own moral. A servant girl, twenty-seven years of age, appeared at the clinic with extensive papules of the mucous membrane of the mouth, and especially of the soft palate, tonsils, and posterior pharyngeal wall. On careful examination with the rhinoscope the mouth of the left Eustachian tube was seen closed and

surrounded by firm infiltration, the surface being opaque, white, and irregular; the cervical lymphatic glands were extensively inflamed. The patient was very deaf, and considered her present trouble due to the repeated use of the catheter six months previously for relief from a former deafness. The hymen was intact, and there was no sign of specific lesion. Ten days later inunction with oleate of mercury was commenced. After thirteen applications and touching of the mouth with nitrate of silver, the local symptoms diminished. The condition of the throat and mouth improved and the hearing increased. The further treatment consisted in simple cleansing of the mouth and throat, and nineteen days later the patient was discharged.

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OPHTHALMOLOGICAL PART.

ACUTENESS OF VISION AND ILLUMINATION.

By ANTON POSCH, at Innsbruck.

(Translated Ferd. C. Valentine, M.D., New York.)

(With Plates II. to VII.)

§ 1. *The Theme.*

In 1872–3 the Medical Faculty of Innsbruck proposed the following theme for a prize essay: "It is desired that observations be made upon the relation between Illumination and Acuteness of Vision, and, if possible, a mathematical axiom framed by means of which this relation shall become demonstrable."

Primarily, it is essential to detail the intent of the theme. When two proximal surfaces unequally illuminated are observed, there must be a definite variance in the illuminations H and *h* of the surfaces, to render the variation appreciable by vision.*

In experimentation upon the sensibility of vision to differences of illumination, under the influence of varying intensities of illumination—the question of acuteness of vision may here be entirely omitted from consideration.

Acuteness of vision, in the generally accepted sense and as comprehended in the above theme, is dependent upon the most minute retinal image, or upon the size of the smallest visual angle, in which two points are recognized, separated by an interval which varies in degree of illumination from these points.

When two differently illuminated pieces of paper are approximated and observed at a distance of one metre, the differences in illumination, H and *h*, will be recognizable and remain so; whether the objects be removed from each other to a distance of two metres, or approached to one-half a metre, the perception of the intensity of illumination will rest unchanged. If, however, a line

* In the elucidative formulæ employed by the author, he has, in the majority of instances, designated his quantities by the initials of the German terms. These I have preferred to retain, with a view towards preventing confusion and misconception in such cases where the German and English designations do not correspond.—Translator.

of a definite transverse diameter, and of the *h* intensity, be drawn upon the H surface, the difference of illumination between *h* and H will cease to be appreciable at a distance of one metre, irrespective of any possible disturbing influences; if, however, they be again approached to a distance of one-half a metre, the appreciation of the difference will again become possible.

Furthermore, if the difference between H and *h* be not made as small as possible, but as marked as possible, as for instance in drawing a black line upon white paper, the difference between H and *h* will not be perceptible, if the visual angle, at which the line appears at a distance of one metre, shall have sunk below a certain degree. The introduction of the angle of vision modifies the question of sensitiveness to the degrees of illumination.

It would be well to enquire what influence the intensity of illumination exerts upon the perceptibility of the differences of illumination: first, without considering the size of the object, and secondly, with the addition of that factor. Notwithstanding the fact that both themes are closely related, they are most frequently treated disconnectedly and individually. The various essential points in this consideration are clearly indicated in Aubert's "Physiologie der Netzhaut."

§ 2. *Fechner's Psycho-physical Law.*

As is known, Fechner applied the psycho-physical law, in view of the influence of objective intensity of illumination, to the ability of vision to distinguish the differences of degree of illumination, without consideration of the size of the object. Definite degrees of perceptibility correspond to definite degrees of illumination. If the illumination be increased, it may be assumed, for at least that extended field upon which it may move, that the susceptibility increases in an arithmetical progression, as the illumination does so geometrically. It may be said that the susceptibility depends upon the logarithm of the degree of illumination, as will be minutely demonstrated farther on.

If the illumination H corresponds to the susceptibility E, and the illumination *h* to the susceptibility *e*, then

$$E = A \log. H + C,$$

and

$$e = A \log. h + C,$$

showing A as well as C as constants in both equations.

Consequently,

$$E - e = \log. H - \log. h = \log. \frac{H}{h}.*$$

The difference of the perceptive powers, therefore the visual susceptibility to illumination, is dependent solely upon the quotient of the illumination. As long as this quotient remains unchanged, the visual susceptibility to differences of illumination is unaltered.

Consequently, the absolute degree of illumination of objects, and those differences of the intensities of illumination which vary therewith, do not exert an impression upon the ability to distinguish the differences of degree of illumination at the object. If one surface of an object be illuminated to a degree of H, and an adjoining surface h a fraction of H, say $h = \frac{1}{2}H$, the difference of illumination of the two surfaces will then amount to $\frac{1}{2}H$. If the objective degree of illumination be quadrupled, then H is increased to 4H and $\frac{1}{2}H$; consequently h to 2H, and the difference $H - h$ is increased four times, viz., from $\frac{1}{2}H$ to 2H. But the susceptibility to degrees of illumination *has not been increased*, because the quotient of the illuminations $\frac{H}{h}$ has remained the same, in both cases amounting to 2.

Fechner has indicated that the psycho-physical law does not apply to either very small or very great degrees of illumination; Helmholtz has demonstrated that it is subject to disturbances in moderate degrees of illumination, and developed a more complicated formula for E.† Aubert totally denies the correctness of the psycho-physical law; his investigations, however, apply to but relatively limited absolute degrees of illumination; the most intense absolute light employed by him was that produced by illuminating a piece of paper with a stearine candle.‡

Hering not only denies the applicability of the psycho-physical law to vision, but also to the other senses.§ Aubert found the following formula, "the result of his limited investigations," that "*the susceptibility for differences of illumination decreases with the logarithms of the intensities of light*,"‖ which is inserted here

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* See Helmholtz, Phys. Optik, p. 312.

† Loc. cit., p. 314–316.

‡ Loc. cit., p. 66.

§ Zur Lehre vom Lichtsinne, 5. Mittheilung, 69. Band der Sitzungsberichte der k. Akad. der Wissenschaften, 1874.

‖ Loc. cit., p. 69.

because of the series of experiments, an account of which will be considered shortly.

The formula sounds similar to the psycho-physical law, but is a negation thereof. According to Fechner's law, the degree of perception is in logarithmic relation to the illumination, and consequently the difference of perceptive powers, the susceptibility to variations of degree of illumination, remains unchanged, when the value of the intensity of the light changes, while, according to Aubert, the susceptibility for differences of illumination varies with the intensity of light and increases arithmetically as the intensity of light progresses geometrically.

§ 3. *Acuteness of Vision and Illumination.*

As to the second theme, the influence of the intensity of light upon acuity of vision, it is universally conceded that the celebrated astronomer Tobias Mayer, of Göttingen, was the first to institute investigations thereupon. He found that when the illumination had attained a certain degree, as for instance that of brilliant daylight, an increase thereof, say to the degree of intense sunlight, ceased to facilitate the perception of systems of lines, or lattice-like or checkered figures. As to minor degrees of illumination, he experimented with a candle, which he gradually removed from the objects to distances varying from one-half to thirteen feet.

In measuring the distances in which he could recognize a system of lines while holding the candle in a certain position, he elicited a basis for the calculation of the visual angle (differing, however, from Helmholtz's manner of calculation), and from the figures thus obtained deduced an empirical formula, according to which, the visual angle being reversed, consequently the acuteness of vision is as the sixth root of the intensity of illumination.* Foerster's† and Aubert's‡ investigations upon the subject did not lead to the deduction of a definite law, nor was the last detailed work of N. Ph. Klein,§ on the influence of illumination upon the acuteness of

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* Experimenta circa visus aciem, in Comm. soc. reg. Goetting. tomi IV. ad annum 1754, Pars phys. et math. pag. 79–112.

† Ueber Hemeralopie und die Anwendung eines Photometers im Gebiete der Ophthalmologie.

‡ Loc. cit., p. 82 et seq.

§ De l'influence de l'éclairage sur l'acuité visuelle. Paris, 1873.

vision, crowned by any such result. Klein speaks of Mayer's formula of one "qui donne des résultats assez rapprochés de la réalité." *

Before proceeding to seek this law, it was necessary to elucidate the definition and values of the correlative quantities "Illumination" and "Acuteness of Vision."

In *illumination*, the first quantity, selected as the voluntarily variable one, it is apparent that it can be considered only *relatively*, inasmuch as no applicable standard has been discovered. This, however, does not exclude a consideration of the relation of the illumination employed to the ordinary standard candles.

The manner in which the *relative* value of the intensities of illumination was developed in my experiments I shall detail hereafter.

The other quantity, *acuteness of vision*, also strictly viewed, cannot be considered other than in a relative sense, for it is evident that visual tests, arbitrarily selected (such as Snellen's type), can lead to no values of *acuteness of vision* which might be considered universally applicable.

If the acuteness of vision be defined by the visual angle, or, what amounts to the same, by its tangents, which demonstrate the relation of the dimensions of the object to the distance in which it remains recognizable, then this definition yields three different methods for the calculation of the relative acuteness of vision.

To formulate this:

$$\text{Acuteness of vision} = \frac{\text{Dimension}}{\text{Distance}}, \text{ or } S = \frac{d}{D},$$

leaving three methods of mensuration, either:

First, d and D;

Secondly, only d, leaving D as a constant;

Thirdly, only D, leaving d as a constant.

The first method is least recommendable, as it is the most intricate.

The second necessitates a change and mensuration of the objects, in which a slight error in observation produces a great one in the result.

* Loc. cit., p. 58.

The third method permits the same object to be retained and measures the visual distance, and is the least difficult.

As I gave preference to the last method, *I defined the relative acuteness of vision by that distance, in which the same object remained equally distinct.*

An interpolation is necessary here. Vierordt * suggested the employment of the square of objects in preference to their linear dimensions, in testing the acuteness of vision. Consequently it became necessary to select the square of the distance, in employing permanent objects. This proposition will not confuse me, because of having calculated the results of experiments of one of these measures, and it will not be difficult to convert the calculations to make them applicable to the other. It suffices that a positive definition be established. Irrespective of this, however, I have selected objects in such a manner that their linear dimensions only can be considered, as shall be discussed later on.

§ 4. *Production of Visual Objects and of the Various Degrees of Illumination.*

Test-type is most frequently employed for the purpose of examining the acuteness of vision. For the purpose of excluding all possible preconception and self-delusion, the examination should be so conducted that the subject thereof shall not know which letters he has before him. The letters must be changed at each occasion, without affecting their degree of recognizability. This is not the case in the employment of Snellen's quadratic test-type, therefore I have preferred to retain the form of the objects, but employed them in varied positions.

After a number of experiments, I employed a series of white lines, separated by black spaces of equal dimensions, and which were filled with discs of a diameter of fifty millimetres. These were pinned through their centre to a piece of black velvet, and gyrated by an assistant in the requisite directions. To elicit the distance of distinct vision, the object was gradually approached to such a distance as rendered the position of the parallel lines clearly recognizable. The greatest distance that they became so was accepted as a basis.

* Graefe's Archives, IX. 1, 1863, p. 161.

It is evident that the similarity of the objects satisfies the requirement of facile cognition, as well as precludes error resulting from preconception or self-delusion. Furthermore, inasmuch as in the recognition of the lines it is only their breadth which is of moment, while their length is immaterial, I believe Vierordt's objection, as stated above, to be thus avoided. An error might occur, if the observer were astigmatic, in which case the acuteness of vision would vary with a variance of the horizontal or vertical position of the lines. I convinced myself of the absence of this defect on my part and that of my assistants, and furthermore employed the artifice of causing the objects to be alternated between two positions of equal inclination to the right or left.

The following point presents more difficulty, and is of greater importance. If an illuminated object be placed upon an absolutely dark background, its degree of illumination alone is to be considered. If, however, the object be surrounded by a luminous margin, then the degree of illumination of both varies with the intensity of light. Therefore, if the correctness of Fechner's law be not premised, then acuteness of vision is to be considered, not only as a function of the intensity of illumination, but as a function of both degrees of illumination. I sought to attain a constant relation of the degrees of illumination by employing the above groups of lines on a white ground with the darkest possible interspaces, because, according to Aubert, the changes of illumination induce a change of the comparative degrees of illumination between white and black, as this does not represent an entire absence of light, being but sixty times darker than the former.*

My source of light was artificial, and I employed two methods for the production of the various intensities of illumination. A first glance reveals the applicability of the law, that the intensity of the illumination decreases as the square of the distance of the source of light is increased. Placing objects in a line, at different proper intervals from an unenclosed lamp, suggests important disturbances to the formation of an exact result, because of the possible reflection from the walls of the site of observation. Therefore the process was modified as follows:

* Loc. cit., p. 73.

The lamp was placed in a magic lantern (Dubosq's lamp, with a system of achromatic lenses), and the resulting strongly diverging cone of light intercepted at the opposite wall by a dark surface. The objects were placed at specified distances in the direction of the projected rays, and in such a manner as not to obscure each other. The distances from the apex of the luminous cone were measured by means of a tape divided into centimetres. Particular attention was paid in placing the objects perpendicularly to the direction of the rays, and all the objects were placed so near the axis of the cone that an error because of the minor intensity of the peripheral rays was not at all to be apprehended.

By means of this arrangement, which is detailed in Fig. 1, Plate II., various advantages were attained. The dangerous mural reflex was avoided, but it facilitated the observation of objects variously illuminated in an equable darkness. The degree of illumination in a room exerts a decided influence upon the susceptibility of the eye (or upon the acuteness of vision), and the resulting complicated phenomena seem less conducive to facile investigation of the physiological law desired.

§ 5. *Experiments according to the First Method, and the Guiding Principles applied to the Selection of the Degrees of Illumination.*

It is by no means immaterial in which ratio the intensity of light is increased, in view of eliciting the simplest possible calculation of the law bearing upon the relation of the acuteness of vision to the intensity of illumination. The selection of the proper ratio premises at least an approximate idea of the law.

If Fechner's psycho-physical law were incontrovertible, as a natural consequence it would have to be assumed that acuteness of vision would be *utterly independent* of the intensity of illumination. It is quite evident that this is erroneous. Visual acuity increases with the increase of the intensity of illumination.

In several experiments I increased the intensity of illumination in arithmetical progression, and it immediately became apparent that the acuteness of vision did not increase proportionately to the increased intensity of light; therefore a straight line was not found applicable for the graphic illustration according to

the usual method of Descart's coördinates. A curve of the second degree was also found unavailable. On the other hand, it appeared as if acuteness of vision increased arithmetically, with geometrical progression of the intensity of illumination.

If the degree of illumination employed be designated by x, and its relative acuteness of vision by y, then

$$x = a\,q^{n-1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1),$$
$$y = \mathrm{A} + (n-1)\,d \quad . \quad . \quad . \quad . \quad (2),$$

for these are the terms of the n members of the geometrical and arithmetical series, beginning with a and A, and with the quotient q, and the appertaining difference d.

We obtain from formula No. 1,

$$n - 1 = \frac{\log.\ x}{\log.\ (a\,q)},$$

and by substitution into No. 2,

$$y = \mathrm{A} + \frac{d}{\log.(a\,q)}\ \log.\ x.$$

$\frac{d}{\log.\,(a\,q)}$ being constant for the same series, it may be designated by B, and therefore the equation would read

$$y = \mathrm{A} + \mathrm{B}\ \log.\ x.$$

Consequently, if the acuteness of vision increases in arithmetical progression as the intensity of illumination is increased in geometrical progression, then the acuteness of vision y increases as the logarithm of the intensity of illumination x.

Now, to test this law in the easiest possible manner, the experimental increase of the intensity of light in geometrical progression suggests itself. I selected the relative values in the series 1, 2, 4, 8, 16, and obtained them, placing the test-objects at distances from the source of light corresponding to

$$1,\ \sqrt{\tfrac{1}{2}},\ \sqrt{\tfrac{1}{4}},\ \sqrt{\tfrac{1}{8}},\ \sqrt{\tfrac{1}{16}},$$

which gave the following result, ten metres being selected as a unit (Pl. II., Fig. 1):

10,000 (*a b*), 7,071 (*a c*), 5,000 (*a d*), 3,536 (*a e*), 2,500 (*a f*) metres.

These distances were continually maintained.

After the room had been darkened by closing the doors and blinds, I arranged a Dubosq's lamp, and placed the objects in the distances from the points of convergence of the rays, as above designated, observing that they were perpendicular to the course of, and as near as possible to the axis of the cone of light. A tape marked in centimetres was attached to a stand, and so placed that its zero coincided with the point of convergence of the rays of light.

The absolute intensity of light was frequently tested with the photometer, as also was done at the end of each series of observations.

The observations were made thus: the observer holding his hand close to his eye, permitted the tape to glide through his fingers, while he approached the objects, to find the distance at which the lines thereon first became discernible. He then drew the tape tense, and caused an assistant to read off and record the length of the distance between the apex of the cone of light and the observer's eye, so that the visual susceptibility of the latter might not be affected thereby. The figures thus found, when deducted from the distance between the apex of the cone of light and the object, gave as a remainder the distance of the eye from the object. This process was repeated at each object. Five or ten such observations are recorded as a series of observations in the tables. The appended tables, thirty-one in number, are each composed of a series of systematic observations, consisting severally of five subseries containing five distinct readings. Four of these series of observations, viz., Nos. III., IV., IX., and X., are detailed upon Plates III. and IV. with their proper curves.

The first horizontal column of each of these tables contains the relative intensities of illumination 1, 2, 4, 8, 16, and their logarithms. The next horizontal column has the visual distances in centimetres, corresponding to the intensities of illumination. Then follows a horizontal row of the arithmetical means, deduced from the values of the vertical columns.

These five mean values were employed to evolve the most appropriate normal, according to the method of the smallest squares of the equation, as annotated under "Remarks."

This equation served for the calculation of the theoretical visual distance, as found in the horizontal column designated "Calculated y." The differences of both these horizontal columns, show the theoretical errors of the investigations, which are to be compared with the probable errors, calculated according to the computation of probabilities, as follows: *

To facilitate rapid retrospection of the comparisons between theory and experiment, the result of each table was depicted graphically, the intensity of illumination being delineated as the abscissa, and the visual distance as the ordinate.

Instead of selecting the distances upon the abscissa proportional to the values of the arbitrarily selected variables, as is generally done, it is preferably recommendable to carry the logarithm of the intensity of the illumination upon the axis of the abscissa; that is to say, to cause a geometrical instead of an arithmetical progression of the abscissa. The values of the abscissa are chosen at equal distances.

Thus the following material advantages were obtained:

First, the curve, which corresponds to the law

$$y = A + B \log. x,$$

becomes a straight line; thereupon follows:

Secondly, that the observations, which are made with varying degrees of illumination primarily, must all result in parallel straight lines when graphically illustrated—naturally premising the validity of the law. The advantage thus obtained consists in the resultant ability to calculate the mean course of the curves, in a large number of observations, even when made with increased intensities of light, by a calculation of the arithmetical mean of each individual observation. An example will serve to elucidate this proposition.

Table III., for instance, presents two systems of lines, of which the upper corresponds to the series of Observations III., and the lower to No. IV.

Each system of lines contains five finely drawn lines, the results of rectilinear combinations of the five ordinates originally observed. It is seen, for instance, that the fine line 1 (III.) begins

* The details of these errors of calculation are omitted.—Ed.

at a distance of 80 centimetres with the 1 intensity of light, while with intensities 2, 4, 8, 16, it indicates the visual distances 101, 140, 208, and 240 centimetres. The heavily dotted line shows the mean value of the visual distances observed. The dark shaded line is the most probable normal, calculated according to the method of the smallest squares. As nearly as the line obtained by experimentation approaches this straight line, so nearly can the law sought be expressed by the equation

$$y = A + B \log. x.$$

Before bringing the results of my series of experiments to a logical conclusion, it will be necessary to convey some especial information pertaining thereto.

My first series of experiments (Series I. and IV.), as well as those of my assistant (Series II.), palpably manifest less precision than the subsequent series, dexterity increasing with practice, as a glance at the 19th to 31st series of observations will reveal an evident tendency to the coincidence of theory and observation.

At the inception, one circumstance particularly served as an especially great source of error. The construction of Series I. and II. (omitted) and especially that of Series IV. (Plate III.), show how conspicuously small the visual distance was found, as first observed with the intensity of 16, thus causing the curves to assume the greatest possible irregularities.

These errors are attributable to the fact that, at the inception of the experiments, the observer's eye had not yet acquired that more acute power of observation and increased susceptibility, which it obtained in the course of the experiments—even after the first reading. Thus it is evident, that if the object nearest the lamp be removed and the second object be examined in lieu thereof, the identical influence will be exerted thereupon ; while on the other hand, if another object be interposed between that which is usually the first and the lamp, or if the observation at the first object be prolonged, this irregularity will disappear.

Exercise adapts the eye to these experiments (Aubert), and when this is accomplished, that most dangerous error, resulting from varying visual susceptibility, is entirely evitated. As the susceptibility increases with each reading, the results present a descending convex curve, instead of a straight line. It would

be erroneous to believe that this arc would reverse its curvature if the readings were made in the opposite order, *i. e.*, from the darkest to the most illuminated object; for the ordinate is increased with the increase of the susceptibility. If the readings were made alternately the curve would be converted into a tortuous line, serpiginously twisted about the straight line.

A sufficiency of examples amply illustrate these cases. Thus, observations in their proper sequence present a properly arc-shaped mean curve, as for instance in Construction III. (Plate III.), which also presents alternate observations with their resultant serpiginous mean curves.

§ 6. *Deductions from the Results, as obtained by the First Method.*

Thus it would appear permissible to view the straight line as a true expression of the law and in consideration of the significance of the law $y = A + B \log. x$ (as given to the abscissæ), acuteness of vision $= A + B \times$ the logarithm of the intensity of illumination, to be viewed as the result of the experiments. Still this is not permissible, because a view of the observations, and even of those made alternately, always presents an arc-shaped curve, with its convexity downwards. Constructions IX. and X. on Plate IV. demonstrate this. It is hardly presumable that this is a mere coincidence.

According to strict scientific principles it is requisite to decide whether the deviations from the straight line herein produced (theoretical errors) lie within the probable errors of observation. A comparison of the theoretical with the probable errors shows the former to exceed the latter, consequently the applicability of the above law cannot be accepted, even though its approach thereto is remarkable.

It would be an easy matter to frame an equation of a curve, by the addition of a third member thereto of the form $C(\log. x)^2$, which would suffice for the mean curve observed. Then the law would be expressed thus: "*Visual acuity increases somewhat more rapidly than the logarithm of the intensity of illumination.*" Then a calculation of a mean of the various curves would no longer apply, because they are not parallel, but mere sections of a larger curved line and each section of a different declivity.

On the contrary, an increase of the absolute illumination to its greatest possible intensity should result in an increase of the declivity of the curves, that is to say, that the constant B increases *pari passu* with the absolute intensity of light. In view of this, the intensity of light employed was determined by a Bunsen's photometer in a number of experiments, and the result reduced to its equivalent in standard candles. But these experiments did *not* demonstrate that increased intensity corresponded with increased B. The most prominent cause thereof is the fact that the degree of visual susceptibility varies so materially during a prolonged stay in darkness. Therefore, it cannot be permissible to compare observations, or to deduce an axiom from observations which were not made seriatim or in the briefest possible intervals. On the contrary, it was necessary to find another method, which would exclude the detrimental influences exerted by varying visual susceptibility. I believe that I have attained such a method, after a number of experiments, in a manner to be detailed farther on.

But it now becomes necessary to insert the tables of my 31 series of observation.

§ 7. *Tables showing Results attained, according to the First Method.*

First series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	60	95	151	231	180	Observations under intensity 16, from 1 to 5 probably not exact, therefore not employed in eliciting the mean.
" 2.....	53	89	144	216	190	
" 3.....	88	102	198	174	180	
" 4.....	66	107	185	206	188	
" 5.....	76	132	140	164	195	
" 6.....	70	93	130	189	206	Observer A.
" 7.....	90	127	152	177	220	The absolute intensity of the light of the lamp was not determined.
" 8.....	75	142	150	214	220	
" 9.....	85	117	120	204	230	
" 10.....	80	112	120	214	250	$y=72.48+126.52 \log x$.
Arithmetical mean	74.3	111.6	149.0	190.7	225.2	
Calculated y.....	72 5	110.6	148.7	166.7	225.8	
Difference.....	+1.8	+1.0	+0.3	+4.0	+0.4	
Probable error in the mean.....	2.6	3.8	5.4	4.5	4 9	

Second series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	80	122	141	208	230	The intensity of the light of the lamp was not determined.
" 2.....	78	101	136	207	224	
" 3.....	84	122	152	206	230	
" 4.....	84	120	159	194	231	Observer B.
" 5.....	85	115	146	204	226	$y=85.48+129.16 \log.x.$
" 6.....	85	117	155	226	236	
" 7.....	86	125	162	232	236	
" 8.....	100	146	180	246	250	
" 9.....	96	127	154	220	241	
" 10.....	95	132	162	225	242	
Arithmetical mean	87.3	122.7	154.7	216.8	234.6	
Calculated y.....	85.5	124.4	163.3	202.1	241.0	
Difference.....	+1.8	−1.7	−8.6	+14.7	−6.4	
Probable error of the mean.....	1.5	2.5	2.3	3.4	1.7	

Third series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	80	101	140	208	240	The intensity of the lamp was not determined.
" 2.....	81	114	140	193	230	
" 3.....	82	117	135	195	231	Observer C.
" 4.....	83	120	148	190	231	$y=75.64+126.60 \log.x.$
" 5.....	87	100	137	193	220	
Arithmetical mean	82.6	110.4	140.0	195.8	230.4	
Calculated y.....	75.6	113.8	151.9	190.0	228.1	
Difference.....	+7.0	−3.4	−11.9	+5.8	+2.3	
Probable error of the mean.....	0.8	2.8	1.5	2.1	2.1	

Fourth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	30	57	115	149	155	In calculating the curve, the observations under intensity 16 were omitted.
" 2.....	37	72	108	176	159	
" 3	43	75	103	152	156	
" 4.....	48	98	111	155	166	
" 5.....	56	70	125	179	156	
Arithmetical mean	42.8	74.4	112.4	162.2	158.4	Absolute intensity of the light of the lamp was not determined.
Calculated y.....	38.6	78.2	117.9	157.5	.....	
Difference.....	+4.2	−3.8	−5.5	+4.7	.....	Observer A.
Probable error of the mean.....	3.0	4.5	2.5	4.3	4.3	$v=38.62+131.61 \log.x.$

Fifth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	89	125	175	187	250	Intensity of light 2 at beginning and end of observations.
" 2.....	95	126	191	200	245	
" 3.....	87	131	194	202	265	
" 4.....	110	129	185	208	265	Observations made in alternate order.
" 5.....	106	152	200	204	260	
Arithmetical mean	97.4	132.6	189.0	200.2	257.0	Observer B.
Calculated y.....	97.9	136.6	175.2	213.9	252.6	$y=97.88+128.49 \log.x$.
Difference.....	−0.5	−4.0	+13.8	−13.7	+4.4	
Probable error of the mean.....	3.1	1.8	0.7	2.7	1 5	

Sixth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	72	103	119	231	255	Intensity of light 2 at the beginning and end of observations.
" 2.....	76	121	130	247	248	
" 3.....	83	120	142	209	270	
" 4.....	90	107	112	212	275	Observations made in alternate order.
" 5.....	65	87	141	194	235	
Arithmetical mean	77.2	107.6	128.8	218.6	256.6	Observer C.
Calculated y.....	63.8	110.8	157.8	204.7	251.7	$y=63.80+156.06 \log.x$.
Difference.....	+13.4	−3.2	−29.0	+13.9	+4.9	
Probable error of the mean.....	3.3	4.2	3.8	6.2	4.9	

Seventh series of observations.

Logarithm of the intensity.	1 1.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	102	124	187	222	284	Intensity of light 2 at the beginning, 2.10 at the close of observations.
" 2.....	103	137	193	220	287	
" 3.....	110	140	200	227	295	
" 4.....	114	150	214	239	308	Observations made in alternate order.
" 5.....	106	143	200	236	307	
Arithmetical mean	107.0	138.8	198.3	228.8	296.2	
Calculated y.....	100.2	147.1	193.9	240.8	287.6	Observer C.
Difference.....	+6.8	−8.3	+4.9	−12.0	+8.6	$y=100.24+155.60 \log. x$.
Probable error of the mean.....	1.5	3.0	3.9	2.5	3.3	

Eighth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	90	147	200	204	273	Intensity of light 2 at beginning and close of observations.
" 2.....	97	141	195	199	270	
" 3.....	93	147	166	199	260	
" 4.....	100	156	198	221	268	Observations made in alternate order.
" 5.....	102	154	195	204	264	
Arithmetical mean	96.4	149.0	166.8	205.4	267.0	Observer B.
Calculated y.....	103.4	143.2	182.9	222.7	262.4	$y=103.40+132.80 \log. x$.
Difference.....	−7.0	+5.8	+13.9	−17.3	+4.6	
Probable error of the mean.....	1.8	1.8	0.6	2.7	1.5	

Ninth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	90	111	185	211	268	Intensity of light 4 at beginning and end.
" 2.....	95	149	164	204	282	
" 3.....	113	133	178	216	287	Alternate order of observations.
" 4.....	99	142	167	242	291	
" 5.....	95	117	195	231	288	Observer C.
Arithmetical mean	98.4	130.4	177.8	220.8	283.2	$y=90.12+152.81 \log. x$.
Calculated y.....	90.1	136.1	182.1	228.1	274.1	
Difference.....	+8.3	−5.7	−4.3	−7.3	+9.1	
Probable error of the mean.....	2.6	4.9	3.1	4.8	2.8	

Tenth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	83	111	150	186	224	Intensity of light 4 at beginning, and 4.17 at the close of the observations.
" 2.....	86	114	173	199	248	
" 3.....	87	119	154	179	250	
" 4.....	90	103	149	202	252	Alternate order of observations.
" 5.....	89	115	163	195	259	
Arithmetical mean	87.0	112.4	157.8	192.2	246.6	
Calculated y.....	79.4	119.3	159.2	199.1	239 0	Observer C.
Difference.....	+7.6	−6.9	−1.4	−6.9	+7.6	$y=79.40+132.54 \log. x$.
Probable error of the mean.....	0.8	1.8	3.0	2.6	4.0	

Eleventh series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	72	101	122	161	183	Intensity of light was not determined.
" 2.....	72	111	125	169	206	
" 3.....	64	109	113	184	214	Observer C.
" 4.....	60	111	113	154	204	$v=66.44+109.16 \log.x$.
" 5.....	64	105	127	164	196	
Arithmetical mean	66.4	107.4	120.0	166.4	200.6	
Calculated y.....	66.4	99.3	132.2	165.0	197.9	
Difference.....	0.0	+8.1	−12.2	+1.4	+2.7	
Probable error of the mean.....	1.3	1.3	2.1	3.4	3.5	

Twelfth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	70	97	115	158	193	Absolute intensity of light not determined.
" 2.....	58	90	115	159	185	
" 3.....	53	82	97	159	180	Observer B.
" 4.....	47	68	85	142	183	$y=50.72+109.31 \log.x$.
" 5.....	54	84	104	140	195	
Arithmetical mean	56.4	84.2	103.2	151.6	187.2	
Calculated y.....	50.7	83.6	116.5	149.4	182.3	
Difference.....	+5.7	+0.6	−13.3	+2.2	+4.9	
Probable error of the mean.....	2.6	3.3	3.8	2.9	2.0	

Thirteenth series of observations.

Logarithm of the intensity.	1 0.00000	2 030103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	103	138	184	236	305	Intensity of light 2 at beginning and close of observations.
" 2.....	88	142	176	240	305	
" 3.....	94	140	205	237	330	Observations made in alternate order.
" 4.....	89	141	193	238	308	
" 5.....	80	139	201	234	312	
Arithmetical mean	90.8	140.0	191.8	273.0	312.0	Observer C.
Calculated y.....	86.4	140.4	194.3	248.3	302.2	$y=86.44+179.19 \log.x$.
Difference.....	+4.4	−0.4	−2.5	−11.3	+9.8	
Probable error of the mean.....	2.6	0.5	3.6	0.7	3.2	

Fourteenth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	59	76	92	138	146	Absolute intensity of light 1 at beginning and end of observations.
" 2.....	55	77	110	142	174	
" 3.....	66	100	130	172	217	
" 4.....	66	95	123	179	213	
" 5.....	63	93	106	191	213	The eye seems to have habituated itself but slowly to minor degrees of illumination.
Arithmetical mean	61.8	88.2	112.2	164.4	192.6	
Calculated y.....	56.3	90.1	123.8	157.6	191.4	
Difference.....	+5.5	−1.9	−11.6	−6.8	+1.2	Observer B.
Probable error of the mean.....	1.4	3.3	4.5	6.9	3.5	$v=56.28\times 112.22\log.x$.

Fifteenth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	73	117	165	187	242	Absolute intensity of light not determined.
" 2.....	92	107	139	188	240	
" 3.....	92	120	165	209	250	Observer C.
" 4.....	110	112	161	193	260	$v=84.32+133.08\log.x$.
" 5.....	101	125	169	229	265	
Arithmetical mean	93.6	116.2	159.8	201.2	251.4	
Calculated y.....	84.3	124.4	164.4	204.5	244.6	
Difference.....	+9.3	−8.2	−4.6	−3.3	+6.8	
Probable error of the mean.....	4.1	2.1	3.6	3.4	3.3	

Sixteenth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	45	64	87	131	183	Absolute intensity of light not determined.
" 2.....	48	67	81	103	165	
" 3	47	77	85	133	182	Observer B.
" 4.....	42	71	80	147	189	$v=36.72+105.57\log.x$.
" 5.....	48	65	85	123	159	
Arithmetical mean	46.0	68.8	83.6	127.4	175.6	
Calculated y.....	36.7	68.5	100.3	132.1	163.8	
Difference.....	+9.3	+0.3	−16.7	−4.7	+11.8	
Probable error of the mean.....	0.8	1.6	0.9	4.9	3.9	

Seventeenth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	111	133	188	232	274	Absolute intensity of light was not determined.
" 2.....	114	142	194	237	268	
" 3.....	105	129	203	239	271	
" 4.....	110	129	173	242	260	Observer C.
" 5.....	100	147	201	234	281	$y=103.40+140.98 \log. x$.
Arithmetical mean	108.0	136.0	191.8	234.8	270.8	
Calculated y.....	103.4	145.8	188 3	230.7	273.2	
Difference.....	+4.6	−9.8	+3.5	+4.1	−2.4	
Probable error of the mean.....	1.7	2.5	3.6	1.8	2.3	

Eighteenth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	82	96	137	150	200	Intensity of light 4 at beginning and close.
" 2.....	74	105	134	162	227	
" 3.....	75	97	150	169	234	Alternate order of observations.
" 4.....	82	102	150	187	203	
" 5.....	81	101	145	172	225	Observer C.
Arithmetical mean	78 8	100.2	143.2	168.0	223.2	$y=71.36+118.46 \log. x$.
Calculated y.....	71.4	107.0	142.7	178.3	214.0	
Difference	+7.4	−6.8	+0.5	−10.3	+9.2	
Probable error of the mean.....	1.2	1.1	2.2	4.1	4.3	

Nineteenth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	98	134	182	249	277	Absolute intensity of light 4 at beginning and close.
" 2.....	105	145	189	227	275	
" 3.....	94	139	184	238	287	Alternate order of observations.
" 4.....	97	140	196	254	272	
" 5.....	100	145	171	235	286	Observer C.
Arithmetical mean	98.8	140.6	184.4	240.6	279.4	
Calculated y.....	96.5	142.4	188.8	234.9	281.0	$v=96.51+153.21 \log. x$.
Difference.....	+2.3	−2.0	−4.4	+5.7	−1.6	
Probable error of the mean.....	1.2	1.4	2.8	3.3	2.0	

Twentieth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	95	122	166	203	258	Absolute intensity of light at beginning 4, and at close 4.17.
" 2.....	64	124	134	188	254	
" 3.....	94	130	174	195	273	Alternate order of observations.
" 4.....	94	134	160	206	265	
" 5.....	83	132	163	198	258	
Arithmetical mean	90.0	128.4	159.4	198.0	261.6	Observer C.
Calculated y.....	84.9	126.2	167.5	208.8	250.0	$v=84.92+137.13 \log.x$.
Difference.....	+5.1	+2.2	−8.1	−10.8	+11.6	
Probable error of the mean.....	1.8	1.6	4.6	2.1	2.3	

Twenty-first series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	92	121	166	222	276	Intensity of light 4 at beginning and end.
" 2.....	104	147	195	226	278	
" 3.....	113	127	188	218	302	Alternate order of observations.
" 4.....	113	131	199	228	310	
" 5.....	113	137	199	234	355	Observer C.
Arithmetical mean	107.0	132.6	189.4	225.6	304.2	$y-94.28+161.91 \log.x$.
Calculated y.....	94.3	143.0	191.8	240.5	289.2	
Difference.....	+12.7	−10.4	−2.4	−17.9	+15.0	
Probable error of the mean.....	2.8	3.0	4.2	1.8	9.7	

Twenty-second series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	69	105	144	180	211	Absolute intensity of light 2 at beginning, and 2.15 at close.
" 2.....	82	116	147	199	250	
" 3.....	73	119	151	198	266	Alternate order of observations.
" 4.....	75	109	153	200	283	
" 5.....	87	117	163	199	282	
Arithmetical mean	77.2	113.2	151.6	195.2	258.4	Observer C.
Calculated y.....	70.2	114.7	159.1	203.6	248.0	$v=70.24+147.63 \log.x$.
Difference.....	+7.0	−1.5	−7.5	−8.4	+10.4	
Probable error of the mean.....	2.2	1.8	2.2	2.5	9.0	

Twenty-third series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	100	129	192	213	268	Absolute intensity of light not determined.
" 2.....	102	132	178	222	262	
" 3.....	108	125	184	217	276	Observer C.
" 4.....	113	139	190	216	276	$y=100.24+139.19$ log. x.
" 5.....	103	148	194	239	274	
Arithmetical mean	105.2	134.6	187.6	221.4	271.2	
Calculated y.....	100.2	142.1	184.0	225.9	267.8	
Difference.....	+5.0	−7.5	+3.6	−4.5	+3.4	
Probable error of the mean.....	1.6	2.7	2.0	3.1	1.8	

Twenty-fourth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	95	105	150	173	220	Absolute intensity of light at beginning 4, at close 4.37.
" 2.....	86	120	156	182	250	
" 3.....	89	126	160	196	246	
" 4.....	80	118	158	190	248	Alternate order of observations.
" 5.....	90	116	171	206	248	
Arithmetical mean	80.0	117.0	159.0	189.4	242.4	Observer C.
Calculated y.....	82.9	121.1	159.2	197.3	235.4	$y=82.92+126.66$ log. x.
Difference.....	+5.1	−4.1	−0.2	−7.9	+7.0	
Probable error of the mean.....	1.7	2.3	2.3	3.8	3.9	

Twenty-fifth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	67	83	110	171	230	Absolute intensity of light 1 at beginning and end.
" 2.....	67	87	124	186	227	
" 3.....	71	82	114	171	212	
" 4.....	64	81	126	175	206	Alternate order of observations.
" 5.....	64	87	118	181	212	
Arithmetical mean	66.6	84.0	118.4	176.8	217.4	Observer B.
Calculated y.....	53.8	93.2	132.6	172.1	211.5	$y=53.76+131.02$ log. x.
Difference.....	+12.8	−9.2	−14.2	−4.7	+5.9	
Probable error of the mean.....	0.9	0.9	2.0	2.0	3.1	

Twenty-sixth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	110	121	190	217	282	Absolute intensity of light 2 at beginning and end.
" 2.....	107	147	193	219	310	
" 3.....	111	135	190	227	310	
" 4.....	120	134	200	235	317	Alternate order of observations.
" 5.....	100	140	186	209	286	
Arithmetical mean	109.6	135.4	191.8	221.4	301.0	Observer C.
Calculated y.....	98.1	145.0	191.8	238.7	285.6	$y=98.08+155.73$ log. x.
Difference.....	+11.5	−9.6	0.0	−17.3	+15.4	
Probable error of the mean.....	2.2	2.9	1.6	3.0	4.8	

Twenty-seventh series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	92	122	180	199	270	Absolute intensity of light 2 at beginning and end.
" 2.....	106	120	165	228	275	
" 3.....	93	132	174	226	297	
" 4.....	103	141	189	230	305	Alternate order of observations.
" 5.....	93	132	175	235	312	
Arithmetical mean	97.4	129.2	176.6	223.6	291.8	Observer C.
Calculated y.....	87.2	135.5	183.8	232.1	280.4	$y=87.16+160.45$ log. x.
Difference.....	+10.2	−6.1	−7.2	−8.7	+11.4	
Probable error of the mean.....	2.2	2.6	2.7	4.3	5.6	

Twenty-eighth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	107	125	182	229	314	Absolute intensity of light 4 at commencement and close.
" 2.....	103	136	193	226	301	
" 3.....	107	140	183	239	308	
" 4.....	109	135	200	233	325	Alternate order of observations.
" 5.....	106	147	208	234	316	
Arithmetical mean	106.4	136.6	193.3	232.2	312.8	Observer C.
Calculated y.....	94.6	145.4	196.2	247.1	297.9	$y=94.56+168.89$ log. x.
Difference.....	+11.8	−8.8	−3.0	−14.9	+14.9	
Probable error of the mean.....	0.6	2.1	3.3	1.5	2.	

Twenty-ninth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	82	112	170	198	280	Absolute intensity of light 2 at commencement and close.
" 2.....	100	137	184	222	287	
" 3.....	91	157	210	229	300	
" 4.....	108	142	195	234	304	Alternate order of observations.
" 5.....	124	144	199	237	309	
Arithmetical mean	101.0	139.0	191.6	224.0	296.0	Observer C.
Calculated y.....	95.3	142.8	190.3	237.8	285.3	$y=95.32+157.79$ log. x.
Difference.....	+5.7	−3.8	+1.3	+3.8	+10.7	
Probable error of the mean.....	4.9	5.1	4.6	4.7	3.7	

Thirtieth series of observations.

Logarithm of the intensity.	1 0.00000	2 0.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1.....	105	133	192	237	306	Intensity of light 4 at beginning, and 4.12 at close.
" 2.....	107	142	204	242	306	
" 3.	108	149	214	244	320	
" 4.....	111	149	204	263	310	Alternate order of observations.
" 5.....	113	162	200	241	330	
Arithmetical mean	108.8	147.0	02.8	245.4	314.4	Observer C.
Calculated y.....	101.8	152.7	2203.6	254.6	305.6	$v=101.76+196.29$ log. x.
Difference.....	+7.0	−5.7	−1.2	−9.2	+8.8	
Probable error of the mean.....	1.0	3.2	2.4	3.0	3.1	

Thirty-first series of observations.

Logarithm of the intensity.	1 0.00000	2 1.30103	4 0.60206	8 0.90309	16 1.20412	Remarks.
No. 1	83	128	170	225	285	Absolute intensity of light 2 at beginning and close.
" 2.....	96	130	182	233	300	
" 3.....	105	129	192	232	295	
" 4.....	110	137	188	233	290	Alternate order of observations.
" 5.....	105	142	197	217	302	
Arithmetical mean	99.8	133.2	185.8	228.0	294.4	Observer C.
Calculated y.....	91.4	139.8	188.2	236.6	285.0	$y=91.44+160.78$ log. x.
Different.....	+8.4	−6.6	−2.4	−8.6	+9.4	
Probable error of the mean.....	3.2	1.8	3.1	2.1	2.1	

§ 8. *Description of the Second Method.*

The source of light employed in the second method was either a lamp, and that continually of the intensity of four standard candles, or sunlight, and the latter in the production of a cone of light, by means of the solar microscope.

In the cone of light, produced either by the lamp or by the solar microscope, I placed a disk of pasteboard which was perforated by four rows of quadrangular oblongs, concentrically arranged, as is detailed upon Plate II., Fig. 2. In the peripheral row the perforations and interspaces were of equal breadth ; in the second the interspaces were thrice, in the third seven times, and in the central row fifteen times the breadth of the perforations. This disk was rapidly gyrated upon its centre by means of a rotatory apparatus. The objects were so placed that the light was transmitted through each circular series of perforations, and another object was placed in unintercepted light. (Fig. 3.) Thus the objects, which were placed in line in the directions α *b*, γ *c*, δ *d*, ε *e*, ξ *f*, and equidistant from the apex of the cone of light, were illuminated in the ratio 16 : 8 : 4 : 2 : 1.

But as those less illuminated were of necessity placed in closer proximity to the eye (*a* in Fig. 3), they caused the above proportions to yield differing degrees of illumination, which are designated " intensity " in the tables of the second method.

For the purpose of viewing all the objects simultaneously from one point of observation, it was necessary that one assistant should properly place them, while another caused the disk to revolve rapidly.

The proximal and synchronous view of the objects precluded the exertion of a detrimental influence which would arise from varying visual susceptibility.

The twenty series of observations obtained thus consist of five subseries, each containing five readings, and were arranged in twenty tables as before. The graphical delineations were also executed as in the first experiments, except that the intensities of light could not be designated in round numbers. Four constructions accompany this on Plates V. and VI. The constructions VII. and VIII. (Plate VI.) refer to lamplight, construction XIV. (Plate VI.) refers to sunlight.

At a mere superficial glance the constructions reveal their greater regularity, and consequently they permit deductions of greater precision. This is attributable to the diminution of the probable errors. A glance at these straight lines, so proximal to the mean curves, reveals the logic of the conclusion that this normal really is almost the true expression of the law in question, and consequently the validity of the proposition, $y = A + B \log. x$, considered within the bounds of the observations made.

Thus we demonstrate that in the employment of lamplight (used in the observations according to the first method with an intensity of illumination of 1 to 4; in those according to the record, of four standard candles), as well as solar light, that within the scope of a single to a sixteen fold intensity of illumination, the law may be thus expressed:

"*Acuteness of vision increases as the logarithm of the intensity of illumination,*" or "*acuteness of vision increases in arithmetical progression, while the intensity of illumination progresses geometrically,*" "or *that the visual angle as well as the size of the most minute retinal image decreases in arithmetical progression, while the intensity of illumination increases geometrically.*"

In employing the qualifying phrase, "within the scope of single to a sixteen fold intensity of light," I follow the rules of circumspection and exactitude, which do not permit the application of the results of experimentation beyond the confines of such experiments, without especially extended inquiry. This caution is more called for in this instance because more minute investigation shows the law to be not strictly valid even within those confines.

If the constructions of the second method be again subjected to a more precise investigation, the mean curve will be observed in eighteen among twenty cases to describe a curve, though not markedly, still appreciably bent upwards. But this result was also attained in the first method.

We cannot consider this as the consequence of the accidental errors of observation, because a comparison of the deviations with the probable errors demonstrates that about two-thirds of the former exceed the latter. The arc-shaped form of the mean

curve is attributable to the fact that in eighteen among twenty cases the deviations were positive in the greatest and smallest intensities of illumination, and negative in the middle ones. Another fact in unison therewith is that the curve has a greater declivity in more intense solar illumination, which, however, cannot be proven because of the variation in visual susceptibility.

Therefore the experiments, according to the second method, demonstrate that *visual acuteness increases with* SOMEWHAT *greater rapidity than the logarithm of the intensity of illumination.*

Aubert experimented with Jäger's test-type, illuminated through openings of various sizes in ground glass plate, which was illuminated by diffused daylight and inserted into a diaphragmatic opening in his dark room. One of Jäger's plates was read at a distance of one metre from the glass plate, subject to a definite size of the source of light. Aubert did not extend his experiments properly; firstly, because test-type is not a proper object for the solution of the problem in question, and secondly, because of his belief that such experiments should be made in another manner.*

For the sake of completeness, I have graphically illustrated Aubert's experiments, as I did my own former ones, for the purpose of discovering whether any material difference in the law would result. For this purpose I employed Prof. Manthner's figures,† which are obtained by converting Jäger's test-types into Snellen's and deducing the visual acuity, and by means of an appropriate process of interpolation I obtained the curve delineated upon Plate VII., to the ordinates and abscissæ of which the same laws of construction apply, as in former experiments. This curve is seen nearly to approximate a straight line, except at its lower part. I have also made a series of experiments according to Aubert's method, which, though not markedly coincident, yield mean curves, which also approximate straight lines.

Therefore the assertion is tenable that Aubert's method yields almost the same results as the two methods formerly described by myself.

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* Loc. cit. pp. 83 and 84.

† Vorlesungen über die optischen Fehler des Auges (neunte Vorlesung), p. 145.

The interpolated values, which were applied to the construction of the curve in Plate VII., are:

Relative intensity of light.	Visual acuteness.
400	1.000
200	0.829
100	0·714
50	0.571
25	0.418
12.5	0.291
6.25	0.200
3.125	0.150

§ 9. *Tables of the Results, as attained by the Second Method.*

First series of observations.

Logarithm of the intensity.	1.00 0.00000	1.75 0.24237	3.07 0.48747	5.52 0.74223	10.15 1.00633	Remarks.
No. 1.....	94	118	145	170	198	The absolute intensity of light of the lamp was fixed at 4 in all the experiments which follow.
" 2.....	91	116	141	166	192	
" 3.....	90	110	136	165	190	
" 4.....	92	117	142	169	196	
" 5.....	90	112	137	166	194	
Arithmetical mean	91.4	114.6	140.2	167.2	194.0	Distance of the eye from the apex of the lamp's cone of light, 324 cm.
Calculated y.....	90.6	115.5	140.6	166.8	193.9	
Difference.....	+0.8	−0.9	−0.4	+0.4	+0.1	
Probable error of the mean.	0.5	1.0	1.1	0.6	1.0	Observer B. $y=90.61+102.62 \log. x.$

Second series of observations.

Logarithm of the intensity.	1.00 0.00000	1.88 0.27432	3.69 0.56742	7.09 0.85044	13.65 1.13525	Remarks.
No. 1.....	68	87	108	128	155	The distance of the eye from the apex of the cone of light, 892 cm. Observer B. $y=66.73+78.22 \log. x.$
" 2.....	64	86	107	127	151	
" 3.....	75	91	109	134	164	
" 4.....	66	89	113	130	156	
" 5.....	72	87	109	139	159	
Arithmetical mean	69.0	88.0	109.2	131.6	157.0	
Calculated y.....	66.7	88.2	111.1	133.3	155.5	
Difference.....	+2.3	−0.2	−1.9	−1.7	+1.5	
Probable error of the mean.....	1.3	3.9	0.7	1.5	4.5	

Third series of observations.

Logarithm of the intensity.	1.00 0.00000	1.77 0.24711	2.95 0.46968	5.41 0.73289	9.85 0.99350	Remarks.
No. 1.....	97	125	150	180	209	Distance of eye from
" 2.....	101	130	155	186	219	apex of cone of light,
" 3.....	101	121	150	179	213	226 cm.
" 4.....	100	122	154	184	218	Observer C.
" 5.....	110	129	150	180	209	$y = 99.53 + 113.29 \log. x.$
Arithmetical mean	101.8	125.4	151.8	181.8	213.6	
Calculated y.....	99.5	127.5	152.7	182.6	212.1	
Difference.....	+2.3	−2.1	−0.9	−0.9	−1.5	
Probable error of the mean.....	1.5	1.1	0.75	0.9	1.1	

Fourth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.72 0.23627	3.13 0.49588	5.72 0.75737	10.39 1.01640	Remarks.
No. 1.....	85	115	136	168	180	Distance of eye from
" 2.....	86	110	141	164	185	apex of cone of light,
" 3.....	88	111	136	159	181	324 cm.
" 4.....	81	104	132	156	188	Observer B.
" 5.....	92	114	135	158	186	$y=87.59+95.87 \log x.$
Arithmetical mean	86.4	110	136.0	161.0	184.0	
Calculated y.....	87.6	110.2	135.1	160.2	185.0	
Difference.....	−1.2	+0.6	+0.9	+0.8	−1.0	
Probable error of the mean.....	1.2	1.3	1.0	4.5	1.0	

Fifth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.91 0.28141	2.72 0.57018	7.08 0.84975	13.72 1.13732	Remarks.
No. 1.....	76	94	117	141	158	Distance of eye from
" 2.....	74	93	118	142	164	apex of cone of light,
" 3.....	72	93	115	137	160	892 cm.
" 4.....	79	97	118	144	168	Observer B.
" 5.....	73	93	112	134	167	$y=72.97+78.52 \log. x.$
Arithmetical mean	74.8	94.0	116.0	139.6	163.4	
Calculated y.....	73.0	95.1	117.7	139.7	162.3	
Difference.....	+1.8	−1.1	−1.7	+0.1	+1.1	
Probable error of the mean.....	2.6	0.5	0.8	1.2	1.3	

Sixth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.89 0.27661	3.51 0.54564	6.56 0.81713	12.26 1.08832	Remarks.
No. 1.....	60	78	102	126	153	Eye at 540 cm. from apex of lamp's cone of light. Observer C. $y=50.70+93.43 \log. x.$
" 2.....	57	78	101	125	153	
" 3.....	54	75	96	124	150	
" 4.....	52	72	96	124	152	
" 5.....	56	74	97	126	159	
Arithmetical mean	55.8	75.4	98.4	125.0	153.4	
Calculated y.....	5.07	76.5	101.7	127.0	152.5	
Difference.....	+5.1	−1.1	−3.3	−2.0	+1.1	
Probable error of the mean.....	1.2	0.8	0.9	9.3	1.0	

Seventh series of observations.

Logarithm of the intensity.	1.00 0.00000	1.77 0.24837	3.13 0.49594	5.50 0.74021	10.24 1.01030	Remarks.
No. 1.....	86	109	135	161	180	Eye at 324 cm. from apex of lamp's cone of light. Observer C. $y=85.33+97.89 \log. x.$
" 2.....	87	109	132	162	181	
" 3.....	85	109	130	157	185	
" 4.....	83	105	132	157	186	
" 5.....	87	110	137	160	188	
Arithmetical mean	85.6	108.4	133 2	159.4	184.0	
Calculated y.....	85.3	109.6	133.9	157.7	184.2	
Difference.....	+0.3	−1.2	−0.7	+1.7	−0.2	
Probable error of the mean.....	0.5	0.6	0.9	0.7	1.0	

Eighth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.88 0 27491	3.67 0.56448	7.15 0.85419	13.74 1.13812	Remarks.
No. 1.....	64	82	104	126	152	Eye at 892 cm. from apex of cone of lamp's light. Observer C. $y=58.28+81.22 \log. x.$
" 2.....	64	81	101	124	153	
" 3.....	60	80	101	120	152	
" 4.....	64	84	101	123	150	
" 5.....	63	83	102	122	150	
Arithmetical mean	63.0	82.0	101.8	123.0	151.4	
Calculated y.....	58.3	80.6	104.1	127.7	150.6	
Difference.....	+9.3	+1.4	−2.3	−4.7	+0.7	
Probable error of the mean	0.5	0.5	0.4	0.7	0.4	

Ninth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.85 0.26809	3.42 0.83332	6.35 0.80257	11.73 1.06920	Remarks.
No. 1.....	58	89	111	143	166	Eye at 540 cm. from apex of lamp's cone of light.
" 2.....	55	80	110	139	162	
" 3.....	55	80	105	129	159	
" 4.....	51	79	111	138	168	Observer B.
" 5.....	56	78	106	138	166	$v=54.12+102.97 \log. x.$
Arithmetical mean	55.0	80.6	108.6	137.4	164.2	
Calculated y.....	54.1	81.7	109.0	136.8	164.2	
Difference.....	+0.9	−1.1	−0.4	+0.6	+0.0	
Probable error of the mean.....	0.8	0.9	1.5	1.5	1.1	

Tenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.85 0.26789	3.46 0.53952	6.50 9.81278	11.93 1.07654	Remarks.
No. 1.....	47	69	96	126	153	Eye at 540 cm. from the apex of lamp's cone of light.
" 2.....	54	76	102	131	156	
" 3.....	48	69	97	128	154	
" 4.....	53	74	101	129	155	Observer B.
" 5.....	58	76	105	129	162	$y=49.18+97.70 \log. x.$
Arithmetical mean	52.0	72.8	100.2	128.4	156.0	
Calculated y.....	49.2	75.3	101.9	128.6	154.4	
Difference.....	+2.8	−2.5	−1.7	−0.2	+1.6	
Probable error of the mean.....	1.4	1.1	1.1	0 6	1.1	

Eleventh series of observations.

Logarithm of the intensity.	1.00 0.00000	1.87 0.27132	3.49 0.54335	6.52 0 81437	12.09 1.08238	Remarks.
No. 1	52	73	94	122	149	Eye at 540 cm. from apex of lamp's cone of light.
" 2.....	53	76	104	125	156	
" 3.....	50	70	95	128	154	
" 4.....	55	78	105	131	158	Observer C.
" 5.....	50	75	98	129	161	$y=49.62+95.93 \log. x.$
Arithmetical mean	52.0	74.4	99.2	127.0	155.6	
Calculated y	49.6	75.6	101.8	127.7	153.5	
Difference.....	+2.4	−1.2	−2.6	−0.7	+2.1	
Probable error of the mean.....	1.3	1.3	2.1	3.4	3.5	

Twelfth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.88 0.27321	3.56 0.55106	6.66 0.82337	12.53 1.09778	Remarks.
No. 1.....	48	66	92	122	153	Eye at 540 cm. from apex of lamp's cone of light.
" 2.....	50	70	93	121	151	
" 3.....	52	72	95	122	152	Observer C.
" 4.....	50	69	89	118	155	$v=44.50+92.34 \log. x.$
" 5.....	44	62	84	110	140	
Arithmetical mean	48.8	67.8	90.6	118.6	150.2	
Calculated y.....	44.5	67.7	95.4	120.5	145.9	
Difference.....	+4.3	−1.9	−4.8	−1.9	+4.3	
Probable error of the mean.....	0.9	1.2	1.3	1.5	1.8	

Thirteenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.87 1.27203	3.57 0.55304	6.74 0.82883	12.72 1.10439	Remarks.
No. 1.....	60	79	104	128	157	Distance of eye from apex of cone of light of lamp, 540 cm.
" 2.....	58	75	99	126	152	
" 3.....	62	84	106	130	159	Observer C.
" 4.....	59	78	101	128	155	$y=57.29+87.28 \log. x.$
" 5.....	60	82	105	130	148	
Arithmetical mean	59.8	79.8	103.0	128.4	156.2	
Calculated y	57.3	81.0	105.6	129.6	153.7	
Difference.....	+2.5	−1.2	−2.6	−1.2	+2.5	
Probable error of the mean.....	0.4	1.2	0.7	0.5	0.8	

Fourteenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.84 0.26375	3.40 0.35106	6.16 0.78949	10.94 1.03884	Remarks.
No. 1.....	157	189	228	273	318	Distance of eye from apex of solar microscope's cone of light, 574 cm.
" 2.....	151	184	219	258	317	
" 3.....	155	182	219	266	323	Observer C.
" 4.....	153	183	224	262	319	$y=147.23+155.03 \log. x.$
" 5.....	155	187	220	269	313	
Arithmetical mean	154.2	185.0	222.0	265.6	316.0	
Calculated y.....	147.2	188.1	229.6	269.6	308.3	
Difference.....	+7.2	−3.1	−7.6	−4.0	+7.7	
Probable error of the mean.....	0.9	0.7	1.2	1.8	1.9	

Fifteenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.86 0.27063	3.43 0.53454	6.34 0.80211	11.77 1.07090	Remarks.
No. 1.....	143	167	200	233	268	Eye at 574 cm. from apex of cone of light produced by solar microscope.
" 2.....	161	194	228	263	291	
" 3.....	167	200	233	270	307	
" 4.....	160	193	230	268	315	
" 5.....	158	180	213	249	286	Observer C.
Arithmetical mean	157.8	186.8	220.8	256.6	293.4	$y=154.79+127.57$ log. x.
Calculated y.....	154.8	189.3	222.9	257.0	291.3	
Difference.....	+3.0	−2.5	−2.1	−0.4	+2.1	
Probable error of the mean.....	2.7	4.0	4.2	4.7	5.6	

Sixteenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.82 0.25990	3 35 0 52498	6.17 0.79043	11.28 1.05220	Remarks.
No. 1.....	149	181	207	246	297	Eye at 574 cm. from apex of cone of light produced by solar microscope.
" 2.....	153	185	217	256	294	
" 3.....	154	184	216	259	289	
" 4.....	153	186	220	259	303	
" 5.....	152	176	207	248	296	Observer C.
Arithmetical mean	152.2	182.4	213.4	253.6	295.8	$y=148.01+136.02$ log. x.
Calculated y.....	148.0	183.4	219.4	255.5	291.1	
Difference.....	+4.2	−1.0	−6.0	−1.9	+4.7	
Probable error of the mean.....	0.58	1.2	1.8	1.9	1.5	

Seventeenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.84 0.26423	3.37 0.52895	6.16 0.78945	10.72 1.03027	Remarks.
No. 1.....	151	181	214	254	298	Eye at 547 cm. from apex of cone of light produced by solar microscope.
" 2.....	154	184	217	256	299	
" 3.....	155	180	215	260	297	
" 4.....	157	186	221	259	303	
" 5.....	157	185	220	261	304	Observer B.
Arithmetical mean	145 8	183.2	217.4	258.0	300.2	$y=148.94+141.15$ log. x.
Calculated y.....	148.9	186.2	223.6	260.4	204.4	
Difference.....	+5.9	−3.0	−6.2	−2.4	+5.8	
Probable error of the mean.....	0.8	0.8	0.9	0.7	0.9	

Eighteenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.87 0.27137	3.37 0.52698	6.17 0.79013	11.35 1.05504	Remarks.
No. 1.....	155	188	232	266	310	Eye at 574 cm. from
" 2.....	143	170	210	250	289	apex of cone of light
" 3.....	145	168	209	247	288	produced by solar mi-
" 4.....	162	186	225	266	308	croscope.
" 5.....	157	188	224	258	298	Observer B.
Arithmetical mean	142.4	179.0	220.0	257.4	298.6	$y=147.95+141.02 \log. x.$
Calculated y.....	146.9	185.3	221.3	258.3	295.7	
Difference.....	+5.5	−6.2	−1.3	−0.9	+3.1	
Probable error of the mean.....	2.5	2.8	3.0	2.7	3.0	

Nineteenth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.86 0.26895	3.38 0.52886	6.16 0.78994	11.17 1.04785	Remarks.
No. 1.....	153	181	218	261	297	Eye at 574 cm. from
" 2.....	157	190	223	257	306	apex of cone of light
" 3.....	150	183	216	259	298	produced by solar mi-
" 4.....	156	188	220	264	300	croscope.
" 5.....	160	190	225	264	305	Observer C.
Arithmetical mean	155.2	186.4	220.4	261.0	301.2	$v=151.02+140.04 \log. x.$
Calculated y.....	151.0	188.7	225.1	261.6	297.7	
Difference.....	+4.2	−2.3	−4.7	−0.6	+3.5	
Probable error of the mean.....	1.4	1.2	1.1	0.9	1.2	

Twentieth series of observations.

Logarithm of the intensity.	1.00 0.00000	1.84 0.26430	3.36 0.52643	6.18 0.79125	11.27 0.05201	Remarks.
No. 1.....	153	183	219	260	300	Eye at 574 cm. from
" 2.....	147	177	216	256	298	apex of cone of light
" 3.....	154	181	218	255	297	produced by solar mi-
" 4.....	150	176	212	251	294	croscope.
" 5.....	156	184	220	260	301	Observer C.
Arithmetical mean	152.0	180.2	207.0	256.4	298.0	$v=146.69+140.61 \log. x.$
Calculated y.....	146.7	183.9	220.9	257.9	294.6	
Difference.....	+5.3	−3.7	−3.6	−1.5	+3 4	
Probable error of the mean.....	1.1	1.1	1.0	1.1	0.8	

§ 10. *An Experiment relative to Fechner's Law.*

The experiments detailed evince, that if the influence of the intensity of light upon the perceptibility of differences of illumination be examined, with consideration of the size of the visual angle—at least if the differences of illumination be made as large as possible, they will yield as a result that susceptibility to variations in intensity of light increases with an increase of intensity of illumination. Finally, I desire to append an experiment which offers conclusive evidence of the fallacy of Fechner's law, though a consideration of the size of the object be omitted and the differences of illumination be made as small as possible, as is done in his (Fechner's) experiments.

The two surfaces of different dimensions may be replaced by two equal surfaces, presenting different inclinations to the source of illumination. A piece of white card-board, of the dimension of half a page, was folded about an acute edge and again separated, thus causing the two halves to form an angle of almost 180°. The card was then fastened to the stage of a Babinet's goniometer, in such a manner as to cause its edge to fall within the vertical diameter of the instrument. Fig. 4, Table II., shows a horizontal projection of the experiment. L is the lamp, *abc* the card, *b* its vertical edge. Behind the lamp and screened from its light by a shade, A marks the position of the observer, and he sees the surfaces *ab*, and *bc*, equally illuminated if they present the same inclination to *b*L. This position is then read off from the graduated circle. Then an assistant slowly rotates the axis towards the right or left, until the moment that the observer at A can determine when and which surface appears less illuminated than the other.

For instance, in the position *a'bc'*, *a'b* will appear more intensely illuminated than *bc'*. The angle, which had to be traversed to make the differences barely perceptible, must be noted. If the intensity of the light be diminished or increased, the angle must be re-determined, and it soon becomes apparent that it must be larger in decreased illumination. If Fechner's law were valid, the same angle would always result.

If the card be so placed that during the employment of a medium intensity of illumination the difference is just observable, it

disappears when the light is reduced, and becomes more apparent with increased illumination. Though the quotient of the illumination remains unchanged, it is evident that the susceptibility increases with an increased illumination of the lighter surfaces, more so than it does with increased illumination of the darker, because the susceptibility increases with illumination.

I desire to close this dissertation with the request that no conclusions be drawn therefrom, other than have been incontrovertibly proven therein. I am well aware that I have not considered the influence of the contraction of the pupil by increased illumination. But this influence does not appear very important in those experiments in which, as for instance in sunlight, even the weakest illuminations yielded marked absolute values.

HYOSCYAMINE.

By Dr. E. PFLUEGER, of Lucerne.

(Translated by Edw. H. Fridenberg, of New York.)

For the treatment of eye diseases atropine is at present the drug most universally employed, being almost indispensable to the oculist. It is of so much importance to us by virtue of its mydriatic, antiphlogistic (at least for the anterior segment of the eye), and narcotic effects, and because it reduces the intraocular pressure. There are, however, two objections to its use, viz., the idiosyncrasy of many persons in regard to the drug, and the fact that its continued exhibition often gives rise to a severe inflammation of the conjunctiva. Efforts have therefore been made to procure a substitute for this alkaloid, it being known that the family of the solanaceæ comprises, besides belladonna, other species, whose active principle has an effect similar to that of atropine [datura stramonium, hyoscyamus niger]. But these preparations being uncertain in their action, and different observers having arrived at widely varying results, especially regarding their quantitative effect, they have thus far found little favor with the profession.

While Cunier (1847), Lematre (1865), Ruete (1866), and Laurent (1870), believe hyoscyamine to be less active a mydriatic than atropine, Hellmann attributes equal strength to both preparations; and Schroff, having considered the subject twice (1856 and 1867), is the only one to whom hyoscyamine seems to be mydriatically more active than atropine.

Ruete used crystalline sulphate of hyoscyamine, manufactured after Geiger's method, Hellmann needle-shaped crystals, the other authors being restricted to the use of amorphous hyoscyamine. Schroff employed Merk's amorphous hyoscyamine.

Under the direction of Professor Dor, in Berne, Rosa Simonowitsch (see these Archives, vol. IV.) performed a series of experiments during the last year with the following preparations of hyoscyamine:

1. The amorphous hyoscyamine of Morson & Co. in London.
2. The hyoscyamine-gelatine wafers prepared in the pharmacy of the Ospedale Oftalmico in Turin.
3. The amorphous hyoscyamine of Merk.
4. The colorless liquid hyoscyamine, distilled according to Merk, in a stream of hydrogen.
5. The crystalline hyoscyamine taken from the collection of Professor Valentin, and prepared in Heidelberg—the results of these experiments being as follows:

The dark amorphous hyoscyamine, having the density of an extract, is always active, no matter whence derived, but not to so high a degree as atropine. Gradually, however, it loses its strength sooner or later, according to the manner in which it is kept. Merk's colorless liquid hyoscyamine, distilled in the hydrogen stream, is entirely inert. The crystalline hyoscyamine had in the majority of cases apparently no effect whatsoever; but as it is almost insoluble, we are hardly able to form a correct opinion of its effect as a mydriatic.

Substances purporting to be pure hyoscyamine, but entirely wanting in mydriatic effect, having been sold lately by chemists, Professor Dor infers: Supposing these preparations to be hyoscyamine, hyoscyamine cannot be a mydriatic, and we must look for the mydriatic elements in the residues. If, on the other hand, hyoscyamine itself be contained in the residuum, the alkaloids obtained, being new chemical combinations, must also receive new names.

The crystalline preparations with which Ruete and Hellmann experimented had mydriatic effect of varying strength, the preparation from the collection of Professor Valentin none or very little.

These three preparations must therefore have been different substances. Either the extractum hyoscyami contains various substances resembling organic bases, but not yet sufficiently separated and distinguished from each other, or the various processes of manufacture, inaccurate as they often are when conducted on a large scale, have generated products of oxydation and reduction of the primitive principles contained in the plant. The latter is the more probable, as we know hyoscyamine to be no very stable chemical compound; for, when dissolved in water, either

in the crystalline or the amorphous form, it does not keep long, while in the semina hyoscyami in the pulverized state it decomposes on exposure to the air.

Perhaps it is the large surplus of ammonia, with which hyoscyamine—retaining this name for the mydriatic principle—is generally precipitated, which induces chemical changes. As to the preparation generated in the hydrogen stream, it is not at all improbable that a reduction of the primitive substance has taken place.

The processes employed in the large chemical factories for the manufacture of hyoscyamine being veiled in secrecy, I imagined that to adopt a stated "modus operandi" for its production would bring us a step nearer to the solution of our problem. I therefore applied to Dr. Stierlin, in Lucerne, who decided for the process detailed in Otto Dammers' "Chemical Dictionary" and consisting in the following steps: Take the seeds of hyoscyamus niger, pulverize, deprive them of their fatty ingredients by the use of petroleum ether, and extract with 85% alcohol and a little hydrochloric acid.

The residues of evaporation are made colorless by being shaken with petroleum ether, saturated with ammonia, and again shaken with chloroform. This washed thoroughly with water yields pure hyoscyamine, either in odorless needles or in an amorphous mass of a damp, repulsive, and stupefying odor. The process employed, though in all cases identical, sometimes yielded the crystalline form, at others the amorphous form. Dammer further states that hyoscyamine is similar in its action to atropine, but that it dilates the pupil more rapidly and for a greater length of time. The hyoscyamine obtained by Stierlin was an amorphous mass, resembling an extract, with an unmistakable alkaline reaction.

The oleum seminum hyoscyami—not to be confounded with the green oleum hyoscyami of the druggist—was the subject of my first two experiments. I found it to contain a mydriatic principle in small quantities. A drop of it was introduced into the eye of a cat, and into the eye of a man; in both cases the pupil was enlarged 1.5 millimetre, and after two days the effect had disappeared completely; the instillation was followed by severe but transient pain, which I believed to have been caused by a residuum of petroleum ether.

All my experiments were made with a solution 1 : 150 hyoscyam. pur. (Stierlin).

Experiment I.—A drop of the solution is introduced into the left eye of a cat. After ten minutes a dilatation ad maximum of 11 millimetres, after 24 hours 10 millimetres, after 36 hours 9 millimetres, and little reaction to light; after this, gradual and continuous contraction of the pupil, especially in the bright light of the sun at noon; on the 7th day, both pupils are equal, even in the light of the forenoon or evening.

Experiment II.—A man, aged 30, suffering from progressive white atrophy of the optic nerve. Width of pupil, 4 millimetres. A drop of H. p., strength 1 : 150, is introduced into the left eye.

After 8 minutes, pupil 7 millim.	After 3 days, pupil 6 millim.
" 10 " " 8 "	" 4 " " 6 "
" 24 hours, " 8 "	" 5 " " 5 "
" 48 " " 6 "	" 6 " " 5 "

Experiment III.—Right eye of a man aged 47, suffering from a shrunken cataract and tremulous iris. Pupil 2.5 millimetres.

After 3 minutes, pupil 3 millim.
" 5 " " 4 "
" 10 " " 6 "

The three following experiments were made at the meeting of the "Naturforschende Gesellschaft," in Lucerne, on the 13th of February.

Experiment IV.—White rabbit. Left eye h. p. 1 : 150, right eye atropini puri 1 : 150. Pupil on both sides, 5 millim.

Left Eye.	*Right Eye.*
After 6 minutes, pupil 6 millim.	After 5 minutes, pupil 5.5 millim.
" 11.5 " " 10 "	" 9.5 " " 8 "
" 15.5 " " 10 "	" 12.5 " " 8.5 "

Experiment V.—Gray rabbit, left eye h. p. St. 1 : 150, right eye atropini sulf. 1 : 150. Pupils on both sides, 3.5 millim.

Left Eye.	*Right Eye.*
After 6.5 minutes, pupil 9.5 millim.	After 5 minutes, pupil 5.5 millim.
" 10.5 " " 10.5 "	" 9.5 " " 8.5 "
" 14.5 " " 11 "	" 15 " " 10 "

Experiment VI.—White rabbit, left eye h. p. St. 1 : 150, right eye hyosc. pur. of Boeringer in Stuttgart, 1 : 300. Pupil on either side 4.5 millim.

Boeringer's preparation is a dark, reddish brown liquid, with a distinct odor of oenanthylic ether, being probably manufactured with the aid of oenanthylic alcohol. I have often employed this preparation with a constant mydriatic effect on man, the effect being less active than that of atropine.

After 16 minutes the left pupil measured 8 millim.; after 15 and 20 minutes the right pupil measured 4.5 millim.; as before the experiment.

Of a number of analogous experiments made for the purpose of finding average values, I will only detail the following, which were favored by a good afternoon's light.

In the three next experiments I used h. p. St. 1 : 150 in the left eye, atrop. pur. 1 : 150 in the right eye.

Experiment VII.—Gray rabbit :

Left pupil 3 millim.	Right pupil 3.5 millim.
After 4 minutes, pupil 4 millim.	After 5 minutes, pupil 3.5 millim.
" 7 " " 5 "	" 9 " " 4.5 "
" 15 " " 9 "	" 22 " " 8 "
" 30 " " 9 "	" 30 " " 8 "
" 60 " " 9 "	" 60 " " 9 "

Experiment VIII.—Gray rabbit :

Left pupil 4 millim.	Right pupil 4 millim.
After 4 minutes, pupil 5.5 millim.	After 8 minutes, pupil 4.5 millim.
" 10 " " 8 "	" 10 " " 5 "
" 16 " " 9 "	" 13 " " 6 "
" 20 " " 9 "	" 15 " " 6.5 "
" 23 " " 9 "	" 19 " " 7.5 "
" 36 " " 9 "	" 33 " " 8.5 "
" 24 hours, " 9 "	" 24 hours, " 7 "
" 48 " " 7 "	" 48 " " 5 "

Experiment IX.—White rabbit :

Left pupil 4.5 millim.	Right pupil 4.5 millim.
After 5 minutes, pupil 9 millim.	After 7 minutes, pupil 7 millim.
" 10 " " 10.5 "	" 8 " " 7.5 "
" 11 " " 10.5 "	" 9 " " 9 "
" 60 " " 10 "	" 10 " " 10 "
" 48 hours, " 4 "	" 13 " " 10.5 "
	" 48 hours, " 4 "

In the two next experiments I used h. p. St. 1 : 150 for the left eye, and at. sulf. 1 : 150 for the right eye.

Experiment X.—White rabbit:

Left pupil 5 millim.	Right pupil 5 millim.
After 8 minutes, pupil 8 millim.	After 10 minutes, pupil 7 millim.
" 9 " " 9 "	" 12 " " 8 "
" 12 " " 9.5 "	" 15 " " 9 "
" 20 " " 9.5 "	" 1½ hours, " 9 "
" 2 hours, " 9.5 "	" 2 " " 7 "
" 2¼ " " 9.5 "	" 2¼ " " 7 "
" 3 " " 9 "	" 3 " " 6 "
" 4 " " 5 "	" 4 " " 5 "

Experiment XI.—White rabbit:

Left pupil 4 millim.	Right pupil 4 millim.
After 4 minutes, pupil 5.5 millim.	After 5 minutes, pupil 5 millim.
" 5 " " 7 "	" 6 " " 6.5 "
" 7 " " 10 "	" 8.5 " " 10 "
" 7 hours, " 7.5 "	" 7 hours, " 5 "

What conclusions can we draw from the numbers obtained, in regard to the strength of the two mydriatics?

There are three points to be considered:

1. The time in which mydriasis occurs.
2. Its maximum.
3 Its duration.

In Experiment III. 3 minutes after instillation of *h.* the pupil had dilated 0.5 millim.

In Experiment VII. 4 minutes after instillation of *h.* the pupil had dilated 1 millim.

In Experiment VIII. 4 minutes after instillation of *h.* the pupil had dilated 1.5 millim.

In Experiment XI. 4 minutes after instillation of *h.* the pupil had dilated 1.5 millim.

In the other experiments 4 minutes had always elapsed before the pupils were measured. This proves that hyoscyamine commences to take effect after 4 minutes, or at times even after 3 minutes.

In Experiment IV. 5 minutes after instillation of A. pur. the pupil had dilated 0.5 millim.

In Experiment VII. 5 minutes after instillation of A. pur. the pupil had dilated 0 millim.

In Experiment VIII. 8 minutes after instillation of A. pur. the pupil had dilated 0.5 millim.

In Experiment V. 5 minutes after instillation of A. sulf. the pupil had dilated 2.0 millim.

In Experiment XI. 5 minutes after instillation of A. sulf. the pupil had dilated 1.0 millim.

I know of no observations in which 4 min. after the instillation of atropine the eye was measured. But the numbers leave it without doubt that atropine is slower to take effect than hyoscyamine. This is especially so in the case of pure atropine, the effects of which can never be demonstrated before 5 minutes have elapsed. Sulphate of atropine acts more strongly than the pure alkaloid, and it is not improbable that its effect may have been observed after 4 minutes. A dilatation of 3 millim. after 5 minutes, as we have observed in Experiment XI. from hyoscyamine, is never seen when atropine is used.

The mydriatic effect of hyoscyamine attains its maximum after 6.15 minutes, the average being 11.5 min.; the mydriasis of sulphate of atropine is complete after 8.5–15 minutes, average 12.5 minutes; that of pure atropine after 12.5–60 minutes, average 30 minutes.

The maximum of the mydriasis of hyosc. pur. in rabbits lies between 3.5 and 7 millim., average 5.5 millim.

The maximum of mydriasis in rabbits for at. pur. lies between 3.5 and 6 millim., average 5 millim.

The maximum of mydriasis in rabbits for at. sulf. lies between 4 and 6.5 millim., average 5.5 millim.

In regard to the maximum of mydriasis, the three drugs under consideration are about equal. Hyoscyamine is certainly not inferior to A. sulf.; A. pur. seems to be the weakest.

To decide how long the effect of these two mydriatics was perceptible, further experiments were performed.

Experiment XII.—Gray rabbit, left eye H. p. St., right eye atrop. pur. Pupil on either side 4 millim.

After 20 minutes, left pupil 9 millim., right pupil 7 millim.
" 30 hours, " " 5 " " " 4 "

In the three next experiments I used H. pur. St. for the left eye, atrop. sulf. for the right eye.

Experiment XIII.—White rabbit:

Left pupil 5 millim., right pupil 5 millim.
After 20 minutes, " " 10 " " " 10 "
" 7 hours, " " 6 " " " 7 "

Experiment XIV.—Gray rabbit.

Left pupil 4.5 millim., right pupil 4.5 millim.
After 12 hours, " " 8 " " " 6 "
" 24 " " " 6 " " " 4 "

Experiment XV.—Cat, 4 o'clock P.M., in the sunlight; either pupil 2 millim.

After 24 hours, l. pupil 8 millim. in sunlight, maximum of dilatation.
" 24 " r. " 3 " " " in the shade 10 millim.
" 24 " l. " 6 " " " maximum of dilatation.
" 48 " r. " 2 " " " in the shade 7–8 millim.

The effect of hyoscyamine could be observed in the sunlight after four days, in the shade after seven days; while that of atropine had disappeared in the sunlight after two days, in the shade after four days.

The hyoscyamine mydriasis remains at its maximum on an average 12–24 hours, Experiment X., in which it had passed in three hours, being an exception to the rule. The maximum of atropine mydriasis is less permanent; in Experiment VIII. the effect of hyoscyamine commenced diminishing after forty-eight hours, that of atropine after twenty-four hours. In Experiments X., XI., XII., and XIV., the effect of atropine had diminished to a greater extent than that of hyoscyamine, both pupils being measured at the same time; in Case XIII., already after seven hours, the dilatation of the pupil from hyoscyamine had receded more than that from atropine. In Experiment X., on the contrary, the atropine mydriasis had passed its maximum within two hours, an observation which has never been made regarding hyoscyamine.

Discrepancies between a. p. and a. s. in the duration of their effect have not been remarked. In cats the duration of hyoscyamine mydriasis is quite remarkable, when compared with that of atropine mydriasis.

As a résumé of all the experiments, we may state: Pure hyoscyamine prepared by Dr. Stierlin, after Dammer's recipe, has an action similar to that of atropine; but it dilates the pupil more rapidly, and for a greater length of time, than atropine does.

I have at different times repeated an experiment already made by Laurent, Simonowitsch, and others, which consisted in injecting a hyoscyamine solution into the anterior chamber of a rabbit's eyes. I removed the eyes immediately after death, and kept them at a uniform temperature. The observations were not continued for more than twenty minutes, as the maximum of hyoscyamine mydriasis is attained in living rabbits, on an average after 11.5 min., and never later than fifteen minutes.

The result was always negative, *i.e.*, there was in no case any mydriasis whatever.

Lastly, I might mention that, after many and varied observations, I can fully endorse the statement of Professor Dor, that in the lingering forms of interstitial parenchymatous inflammation of the cornea, hyoscyamine is productive of far better results than atropine.

ON GLAUCOMA AND IRIDECTOMY.

By Dr. J. SCHNABEL, of Vienna.

(Translated by Dr. Th. R. Pooley, of New York.)

In order to understand the nature of a disease, we must first define the boundaries of the group of diseases to which it belongs.

These being determined, we have to ascertain the symptoms of the individual diseases belonging to this group and their mutual relations, and then trace to a common origin all those symptoms that we cannot deduce from any of the other diseases. As regards the definition of the group of glaucoma, an agreement was obtained after some hesitation, and, following Donders and v. Graefe, we now designate all those diseases as glaucomatous where an excavation of the papilla with steep margins is produced, occupying the entire surface of the optic nerve and caused by increased tension. The pathological increase of tension and the characteristic and easily recognizable form of excavation of the optic nerve were found to be associated so constantly, that the sole existence of increased tension at the time of examination, or the mere presence of that excavation, are sufficient to make the diagnosis. We can expect the excavation to form very soon in the first instance, while in the second we are entitled to presume that an increased tension had formerly existed.

But a universal agreement as to the relation of the individual symptoms of glaucoma to each other and their common origin has not been accomplished as yet.

As the rise of intra-ocular pressure beyond the physiological limit proved to be a constant and highly important symptom, and in a large number of cases of glaucoma all the symptoms were explained by this increase of intra-ocular pressure, Donders regarded the latter as the essence of glaucoma.*

According to Donders the inflammatory symptoms, the occurrence of which cannot at all be deduced from an increase of the

* Haffman's Beiträge zur Kentniss des Glaucoms, Arch. f. Ophth., viii., p. 144.

intraocular pressure, do not necessarily belong to this process, and are only complications. In this way the non-inflammatory glaucoma became the type, and a distinction was made between glaucoma simplex and glaucoma complicatum (cum inflammatione).

Donders' view contains the supposition that inflammatory glaucoma can only occur in such eyes as were previously the seat of glaucoma simplex. It has been repeatedly shown by clinical observations that acute glaucoma of a perfectly sound eye did occur in individuals during their stay at the hospital, on account of glaucoma of the other eye. Besides this we find that the glaucomatous inflammation is a peculiar one : it never occurs in other diseases, and is rarely entirely wanting in cases of glaucoma simplex ; it greatly influences the fundamental symptom of glaucoma simplex, namely, the increase of intra-ocular pressure, for the latter occurs either simultaneously with the inflammation, or is intensified at the time of its onset. It is therefore difficult to suppose that this very characteristic form of inflammation bears only an accidental relation to glaucoma. For this reason Graefe insisted on his former views, maintaining in opposition to Donders that glaucoma is an inflammatory disease, a form of iridochoroïditis, that will naturally cause increased tension and its consequences.

According to v. Graefe, inflammation is the fundamental process in both glaucoma simplex and complicatum, and the difference between these two forms is only quantitative.* Inflammation is the cause of the increased tension, and the latter the source of all other symptoms.

This view explains the increased tension and recognizes duly the undeniable intimate relation between the pathological increase of tension and the glaucomatous inflammation, and allows us to trace all cases of glaucoma, without regard to their form, to a common origin ; but it considers a great number of cases as inflammatory that do not present anything to justify this designation. It is impossible to convince ourselves that glaucoma simplex is caused by an inflammatory process, and it is the duty of the clinical observer to prevent a process without any undoubtful inflammatory symptom from being called inflammation.

* Archiv f. Ophth., xv. 3, p. 198.

V. Graefe's views therefore do not promote our knowledge of the nature of glaucoma.

All other efforts to obtain information of the origin of glaucoma were directed to the cause of the pathological increase of tension.*

Had they been successful, they would only have given us a clearer idea of glaucoma simplex, and would not have elevated us above Donders' views.

But a pathological increase of tension is not glaucoma, and the final theory of glaucoma must also explain the cause of the inflammation.

The following are the symptoms of glaucomatous inflammation: Turbidity of the vitreous and aqueous humors and of the cornea, ciliary injection, and pain. The diffuse opacity of the vitreous humor is generally regarded as the most important of the objective symptoms, and is thought to be constantly present. V. Graefe says that it principally occupies the inferior part of the vitreous body, is perfectly diffuse, and can disappear entirely without causing any alteration of the structure of the vitreous body. He is of the opinion that it is this characteristic affection of the vitreous humor which distinguishes the glaucomatous serous choroïditis from that not accompanied by increased tension. The opacity of the cornea, on the other hand, he regards as of minor importance. All other authors make the same statements as regards the constancy and importance of the opacity of the vitreous body and the insignificance of the corneal affection.

Schweigger only, says in the recent third edition of his treatise of ophthalmology that the diffuse opacity of the cornea is the most apparent and important of the opacities of the different media in cases of inflammatory glaucoma, and that it is found early and constantly, while a simultaneous opacity of the vitreous body could never be demonstrated.† My investigations have taught me that in every case of inflammatory glaucoma, where it was impos-

* See Coccius, Beitrag zur Lehre von dem Wesen des Glaucoms, Arch. f. Ophth., ix., 1, p. 21, und der Mechan. d. Accommod., p. 92. Wegner, Experimentelle Beitr. zur Lehre vom Glaucom, Arch. f. Ophth., xii., p. 20. Adamük, De l'étiologie du glauc., Ann. d'Ocul., tome lviii., p. 5–13. Ref. in Zehender's Klin. Mon.-Bl., v., p. 328. V. Hippel, Ueber den Einfluss der Nerven auf die Höhe des intraocul. Drucks, Klin. Mon.-Bl. f. Aughkde., vi., p. 386. Stellwag, Der Intraocul. Druck, p. 35–46, und Lehrbuch der pract. Aughkde., 3. Aufl., p. 347.

† L. c., page 519.

sible to examine the fundus on account of the opacity of the media, there existed such a dense opacity of the cornea that we could not judge of the state of the vitreous body. They have also taught me the following facts: When the opacity of the cornea permitted to some extent an examination of the interior of the eye, there was never found any opacity of the vitreous body. In cases where the cornea was perfectly transparent there never existed any opacity of the vitreous body.

The variations in the degree of transparency of the media in cases of glaucoma and the variations in the visual acuteness were directly proportioned to the increase or diminution of the corneal opacity. The variations in the visual acuteness never depended on an altered state of the vitreous body. In view of these observations it is not permissible to insist on the supposition that a diffuse opacity of the vitreous body occurs with acute glaucoma. With particular reference to the circumstance that every grave inflammation of the interior of the eye is accompanied with more or less opacity of the vitreous body, I must emphasize the fact *that glaucoma is characterized by the absence of opacity of the vitreous body*. The opacity does not occupy the entire cornea so far as I could learn as yet. It is most frequently found at the pupillary region, and leaves the peripheral parts unaltered. It is superficial, does not generally cause any change in the epithelium, so that the cornea retains its normal lustre and an unchanged reflected image. It is due to this circumstance, in a great measure, that the corneal opacity has not received the attention which it deserves. In some cases the epithelium is loosened, and looks as if pricked with pins; in cases of old inflammatory glaucoma and glaucoma absolutum the corneal surface sometimes becomes distinctly rough. The opacity is well defined and generally of uniform density in the affected parts. Occasionally it is interrupted by islands of transparent corneal tissue, and it looks very much like ground steel polished only at a small and well-defined spot. The opacity appears suddenly, attains its greatest density rapidly, and disappears as suddenly as it came. The attacks of corneal opacity occasionally run a typical course; at times, however, they show no typical characteristics, recur after irregular intervals, and vary in duration, lasting only a very short time, *i.e.*, 2–3 hours in some cases, and continuing for weeks with varying intensity in

others. But even that of long duration disappears entirely in a very short time. It never passes into the stage of suppuration, and never leaves a noticeable permanent opacity.*

I have observed the most exquisite cases of corneal opacities in eyes which were not the seat of glaucoma at the time. As these cases of opacity exhibited the most perfect coincidence with those observed in glaucoma, and as the disease of the cornea now under consideration has not yet been described, I will take the liberty of dwelling on these cases for a greater length of time.

The first case was that of a female patient, 25 years of age, who was admitted to the ophthalmic division of the general hospital on account of specific iritis and retinitis of the left eye. She was treated by inunctions. The iritis disappeared entirely, and the eye assumed its normal appearance. One morning she told me that a marked diminution of sight had occurred the day before, had lasted but a short time, and then disappeared. No further attention was paid to this complaint, as the eye was found unaltered. The complaint was repeated the next day, but the ophthalmoscopic examination furnished no explanation of the occurrence, and the functional examination showed no new disturbance. I then visited the patient at the hour at which, according to her statement, the visual disturbance had occurred on the previous day, and found increased tension of the left eyeball. The cornea was so opaque that an ophthalmoscopic examination could not be made. Pericorneal injection did not exist. These attacks of opacity of the cornea and increased tension were repeated daily for three weeks. Precisely between half-past ten and a quarter to eleven the disturbance of vision suddenly occurred, "as if thrust at the patient." Sight diminished rapidly, and remained bad until one P.M., when the normal condition was almost suddenly re-established. These attacks were not accompanied by pain, redness of the eye, or disturbances of any other kind. Her sight, equal to $\frac{10}{40}$ before and after each attack, was so reduced during the attack that she could only count fingers at a distance of a few feet.

The suddenness of the onset and disappearance of the opacity were most remarkable. Once while I made an opthalmoscopic examination of this patient, Prof. v. Jaeger asked me whether I could see anything. As I affirmed this, and he had convinced himself of the transparency of the cornea, he assured me that he had tried in vain before to throw any

* Although in my experience such opacities never remain, I nevertheless think it possible that the grayish white, cloud-like, and stationary spots found at times in eyes iridectomized for glaucoma may directly depend upon the early infiltration of the cornea.

light through the opaque cornea. In the beginning there was an increased tension of the globe during the attacks only, but later it was found to exist also during the intervals. In consequence of the occurrence of slight mydriasis and moderate sluggishness of the pupil, the globe presented a slightly glaucomatous appearance, and I thought it possible that iridectomy would prove necessary. But three weeks after the beginning of the affection the attacks diminished in frequency and duration, and finally ceased entirely. The patient was discharged four weeks after the last attack with S = $\frac{1}{40}$. The pupil was round, black, and movable, but larger than the right one, and considerably larger than normal. The cornea was perfectly transparent, and the tension a little greater than on the right side. The ophthalmoscopic examination did not reveal any of the characteristic alterations of glaucoma.

The second case was that of the father of one of my colleagues, Mr. M. He came to me December 28, 1875, complaining of dimness of his left eye, that had already lasted some weeks, and came on every evening suddenly between 7 and 7½. He first noticed a ring of rainbow colors around the flame of his lamp; this rapidly succeeded by a fog that became more and more dense, but never became so thick as to prevent him from seeing large objects. He was, however, obliged to discontinue playing cards, which he was accustomed to do at that hour. Having lasted from one hour to one hour and a half, the dimness of sight gradually diminished, and the fog became thinner. Finally the rainbow appeared, and after 9 or 9½ o'clock, with the disappearance of the rainbow his sight was as good as before. I found a high degree of hypermetropia of both eyes. The right eye was amblyopic, very strongly deflected outward in consequence of a division of the rectus internus. The left eye S = $\frac{2}{20}$ with + $\frac{1}{8}$. Its tension and visual field were normal. The ophthalmoscope did not find the slighest anomaly. I requested the patient to visit me during such an attack of dimness. On January 3, 1875, the patient came to me at 9 P.M., remarking that the attack had this time already commenced at 7, and was especially intense. I found so much opacity of the central part of the cornea that, although I received light from the fundus and was enabled to exclude positively any opacity of the aqueous and vitreous humors, I could not recognize any details at the fundus of the eye. The epithelial layer of the cornea was smooth, reflecting, the pupil of normal size and motility, and the tension was moderately increased. He read No. 9 with difficulty. The following day, the patient informed me that the attack of yesterday had terminated at 10½ o'clock, that he now read again No. 1 at a distance of 12 inches. S. was $\frac{2}{20}$ and the slight increase of tension had disappeared. I ordered

for the patient quinine, and subsequently tinctura Fowleri. The typical attacks continued for some time, occurring every third day; later they became irregular in type. The patient, for instance, was well ten days in succession. There followed five days on each of which he had a slight attack of short duration, marked by the appearance of rainbow colors around the flame of his lamp. Then came an attack of great intensity, during which the chimney of a burning oil lamp appeared as if covered by numerous small fissures and cracks, forming the centre of a luminous ring. There were only slight attacks in March, which occasionally repeated themselves on four or five successive days, and then recurred again after an interruption of eight or ten days. The same was the case in April. Qualitatively the attacks were perfectly alike—they always occurred at the same time. The treatment produced only an alteration of the type, intensity and duration of the attacks. I saw the patient last on the 28th of April, and found the eye normal in every respect at the time of the examination. Of the subsequent history of the case I am not informed, but there is every reason to suppose that the affection has entirely disappeared and the eye remains healthy.

So far I have not had the opportunity of observing the constant recurrence of these corneal opacities after a certain time; but I do not think I err in supposing that in the numerous cases of glaucoma, where a periodical occurrence of dimness and the appearance of rainbow colors are observed, such a corneal affection to be the cause of these symptoms. I would like to refer to the history of Mina Dankhoff, published by v. Graefe in the Arch. f. Ophth., vol. iii., p. 520. Even the rule to operate as soon as possible after the diagnosis of glaucoma has once been made, renders it impossible to observe such occurrences at the clinics frequently. But I have often seen irregular types of the above described opacity of the cornea recurring once or several times in patients waiting several days at the clinic for the operation.

In a girl 14 years of age, with a classical glaucoma simplex of both eyes, I found on the 11th of January, 1875, perfectly clear media on both sides; L. amaurosis. She is able to count fingers at a distance of 25 feet with the right eye. January 13th, at 10½ A.M., the patient complained that her sight had diminished since a short time. Even with the naked eye I could observe the opacity of the cornea that had set in in the meantime, and which extended almost to the margin of the cornea.

It diminished the sight to such a degree that the patient could count fingers at a distance of ten feet only with difficulty. The opacity permitted the return of light from the fundus of the eye, and I could determine that neither the aqueous nor vitreous humor, nor any other part of the interior of the eye, had suffered any change, and that therefore the anomaly was confined to the cornea. At 1¾ P.M. the dimness had entirely disappeared, and she could count fingers at a distance of twenty-four feet. At my visit on January 14th, at 9½ A.M., I again found the opacity. This time it only extended over the pupillary region, and was extremely well defined. The surface of the cornea was perfectly smooth. In the opaque region I found a vertical, linear, well-defined transparent part, ½‴ in breadth. She could count fingers at a distance of 12′. During the existence of the opacity iridectomy was performed. Light was improved by the operation, and after four weeks the young patient could count fingers at a distance of 35′. I had the opportunity of observing the patient for several months after the operation. Numerous measurements showed sight to be always the same, yet the patient complained of a periodical dimness. She stated at times that on some days she could not see very well from nine in the morning until two in the afternoon, and whenever I visited her she would call out that she was doing well or badly that day. Though I took great pains to find an objective change during the period of visual impairment, I did not succeed; nay, in spite of the patient's positive assertions that her sight was impaired at the time of the examination, and that everything was more foggy than an hour before, I found the same formula for S. as at the time when, according to her statement, she could see distinctly.

These complaints generally occur before and after iridectomy in cases where the excavation is well developed, while the other symptoms of glaucoma are not at all marked, or are either entirely wanting or show only an increase of tension. I recollect especially the case of a man who was operated upon in both eyes on account of glaucoma simplex, and who assured me every day after the iridectomy that he could see very well up to 9 A.M., when a fog descended in front of his eyes, "just like an ordinary fog," and remained there until evening. Though I found the same degree of sight at the time when the patient praised his condition as when he complained very much, he still asserted that his sight was impaired, though he could see objects of the same size at the same distance.

Two varieties of periodical obscuration must therefore be dis-

tinguished in cases of glaucoma. The one occurs suddenly, attains a high degree, and is characterized objectively by the corneal opacity. It is completely relieved by iridectomy. Vision of rainbow colors is associated with it. We only need compare the beautiful colors around the flames of the street lamps, if viewed through a window pane upon which we have breathed, with those which the intelligent patient whose history was published by Heymann in the 5th volume of the "Klinische Mon.-Bl. f. Aughlk.," stated to have seen around the flames, to convince ourselves of the perfect analogy of the cause by which both are produced. The second variety of periodical obscuration is not removed by iridectomy. It is characterized by the absence of any change in the eye that can be shown objectively, and by the want of any demonstrable diminution of light. It is evidently dependent upon a disease of the perceptive apparatus.

In cases of chronic and acute inflammatory glaucoma, I often noticed the corneal opacity from the time the patients entered the clinic until iridectomy was performed. But after the latter operation the opacity disappeared promptly without ever returning. In cases of inflammatory glaucoma the opacity of the cornea is one of the most constant symptoms. It was entirely overlooked, and its effect was thought to be due to opacity of the vitreous body. A few excellent cases are found in literature where this opacity of the cornea was regarded as a remarkable complication, or as a keratitis masking the glaucoma.* A case of Schiess, published in the 10th volume of the "Klin. Mon.-Bl. f. Aughlkde.," is of the greatest interest in this respect.

The description given by Schiess of the opacity of the cornea, which he regards as a diffuse keratitis, corresponds exactly with what has been observed by me. The following is that part of the history which contains this most exact description of the corneal affection. "The opacity is a peculiar one. The surface of the cornea has not lost its lustre, as is usual in diffuse keratitis. The cornea looks speckled, as if, after sprinkling drops of water on a previously smooth and shining piece of ice, the whole surface had again frozen." †

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* Haffmann's Arch. f. Ophth., viii., 2, p. 153. Coccius, Arch. f. Ophth., ix., 1, p. 7.

† L. c., p. 332.

To all appearances this opacity, which was so dense that it made the examination of the fundus impossible, had lasted for fully five months before iridectomy was performed, and yet the cornea became transparent the day after the operation, and was perfectly clear three days later.

We are accustomed to regard every recent transient opacity of the corneal tissue as a sign of inflammation. This does not prove correct for every corneal affection of the above-described nature. I shall only mention the formation of vesicles on the cornea. A boy on whom extraction had been performed with perfect operative success, but who was not at all benefited by the operation on account of a pre-existing detachment of the retina, remained for this reason at the clinic long after the eye operated upon had returned to the relatively normal state. I observed in this patient on three successive days 20–30 small vesicles suddenly appearing on the cornea without any other change of the globe. They were as large as poppy seeds, had a smooth surface and a spherical form, and disappeared after several hours without leaving any trace of their existence. Such a process cannot be called inflammation. Nor are we entitled to regard as a consequence of inflammation an opacity occurring in a previously healthy cornea in a sudden manner, on many successive days, without any injection of the vessels or pain, not leaving any permanent products, disappearing again suddenly without any suppuration, and furthermore characterized by its rapid and perfect curability by iridectomy. Schiess is of the opinion that the opacity "occurring without any pericorneal injection or any other irritation is the direct consequence of the increased intra-ocular pressure, with which it also almost suddenly disappears.* This relation points undoubtedly to a connection between increased pressure and the corneal affection, but the former is not necessarily the cause of the latter. *I believe that the occurrence of the opacity now under consideration is not due to a pathological accumulation of fixed elements in the cornea, but that it is dependent upon the secretion of a turbid fluid; and taking into consideration the course, which evidently shows a dependence of a disease of the nerves, I am forced to regard the periodical opacity of the cornea which we en-*

* L.c., p. 334.

counter in all the various forms of glaucoma, most frequently in the inflammatory variety, but also in eyes which are not the seat of glaucoma, with or without increase of tension, as a neurosis of the secretory nerves.

V. Hippel describes a case where, after a pre-existing pain in the course of the trigeminus, a slight opacity of the cornea, with a superficial desquamation of the corneal epithelium and a simultaneous diminution of the ocular tension, was several times observed.* This disease of the cornea, which healed very soon each time without progressing to suppuration or opacity, unquestionably belongs in the same category with those observed in cases of glaucoma.

The pain associated with glaucoma presents peculiarities that distinguish it very decidedly from the symptomatic pain of inflammation. It generally appears and disappears suddenly, presents a regularity as to the time of the attacks, and is not at all proportionate with the other phenomena of inflammation as far as its intensity is concerned. It sometimes is of the greatest intensity when inflammation is entirely wanting; nay, it presents itself before we notice any marked symptom of glaucoma. Several cases have been described where a trigeminus neuralgia was followed by glaucoma, and an intimate relation between the two diseases unquestionably existed.† A case observed by me shows that a neuralgia of the trigeminus may be the first symptom of glaucoma.

Mrs. Rosa G., aged 56 years, was attacked in August, 1872, by a severe pain in the forehead over the right eye. The pain recurred daily at about 9 A.M., and lasted until evening without assuming any definite type. It was confined to the supra-orbital region, and never so severe as to prevent the patient from doing her housework. Obscured and colored vision of the right eye was constantly associated with this pain. Occasionally the disturbance of vision preceded the pain, but the former was never wanting, and always disappeared entirely with the latter. The patient felt perfectly well in the morning and evening. I had no opportunity of

* V. Hippel, Ernährungsstörungen der Augen bei Anästhesie des Trigeminus, Arch. f. Ophth., xii., 1. p. 53.

† Hutchinson, Ophth. Hosp. Reps., vols. iv. and v., and reference in Schmidt's Jahrb., Bd. cxxi., p. 221, and Bd. cxxi., p. 310. Wegner, Arch. f. Ophth., xii, 2, p. 1. V. Hippel, Arch. f. Ophth., xiii., p. 49.

examining her during an attack. The ophthalmoscopic and functional examinations made during the free period did not reveal the slightest anomaly. I ordered quinine, without producing any result in the beginning. Later on, the desired effect was obtained by quinine in larger doses and in solution. The trouble disappeared, having lasted for six weeks. In August, 1873, the patient informed me that she had had slight touches of her old trouble, but that she was satisfied with her present condition. I examined her and found normal conditions. In November, 1873, the pain recurred in the right supra-orbital region. It set in every day, and gradually increased to an intolerable intensity. It then diminished in severity, and ceased entirely towards evening. The pain on the right side appeared and disappeared simultaneously with the impairment of vision. I did not see the patient, who lived in a small country town of Bohemia, during that time, but I frequently obtained reliable information from her physician, and afterwards a report from the very intelligent patient. This time quinine did not relieve the pain. In January, 1874, I advised the use of tinctura Fowleri. A very marked improvement followed the use of this remedy in the beginning, but it had no influence on the attacks that recurred after an interval of two weeks. In the latter part of January the region above the left eye also became painful, and as the patient had become exhausted and confined to bed, she was removed to Prague. V. Hasner diagnosticated glaucoma, and on February 2d performed iridectomy outward on both eyes. During the entire course of the disease the eye itself was at no time the seat of pain. A transitory redness occurred only once, in consequence of the instillation of atropine by the attending physician, and in spite of the greatest attention nobody could find any other change than a moderate dilatation of the pupil. Iridectomy completely relieved at once the most intense pain, which had lasted almost three months, and which existed on the day of the operation just as much as on every preceding day; and thus the dependence of the neuralgia from the condition of the eye was shown in the most conclusive manner.

It is evident that the neuralgia was not the cause, but the consequence, or rather a symptom of the glaucomatous process. It is not necessary to prove especially that the neuralgia was not a symptom of inflammation, as there was no inflammation present.

In August, 1874, I saw the patient again. The right pupil was somewhat larger and the tension of the right eyeball somewhat greater than that of the left. There was a slight glaucomatous excavation on the right side; the left eye seemed to be perfectly normal. I did not have the means of

determining her acuteness of vision with exactness, but can state that the patient, with the aid of her spectacles, could read printed matter of the size of Jaeger No. 5 quite fluently, and she assured me that she could see with her left eye just as well as previous to her disease. The right eye is only a little worse than the left. In September, 1874, slight pain was noticed below the right eye, and only recurred for a few consecutive days. In March, 1875, she was suffering from pain in the top of her head, of fearful intensity and surpassing by far the previous attacks in this respect. The attacks commenced at 7 A.M., and terminated at about 1½ P.M. The duration of the present illness was five weeks, and towards the termination of the attack the patient complained of a slight pain in the right, and intense pain in the left supra-orbital region. This time the eye did not suffer at all. Very large doses of quinine stopped the pain. I examined the patient on the 17th of May, and found the eyes in the same state as in August, 1874.

In the case of Barbara Ritzmann, reported by Wegner, the symptoms observed at the beginning of the disease of the left eye presented much similarity with those which for some time existed in my patient. In the former case iridectomy did not relieve the supra-orbital neuralgia, which was therefore not dependent on the disease of the eye; but it removed completely the very intense pain present in the eye itself, though there were no signs of inflammation. The same result was obtained subsequently by iridectomy of the right eye.

We see, therefore, that the ocular and circumocular pain present in cases of glaucoma simplex must be regarded as of neuralgic nature, and that those analogous attacks of pain occurring in cases of inflammatory glaucoma are not a sign of the inflammatory process, but the expression of an independent affection of the nerves.

The episcleral injection, the only remaining symptom of inflammation, cannot alone prove the presence of inflammation. We know that in cases of hemicrania the corresponding eye becomes very frequently red and photophobic, and secretes a greater quantity of tears. Romberg relates the full history of a man "who was for 26 years a pitiable sufferer from facial neuralgia," and he remarks that "whenever the ramus ophthalmicus was involved, the eye became as red as blood, just as in higher degrees of traumatic ophthalmia," and remained so during and for some time after the

attacks. "There was also swelling of the eyelids and a copious flow of tears at the same time."* The hyperæmia caused by and appearing with the neuralgic attacks receives a peculiar characteristic feature from the simultaneous occurrence of an anomaly of tension, and it is for this reason that the hyperæmia does not subsequently entirely disappear.

While, then, I pronounce that the symptoms of glaucoma hitherto considered as inflammatory are only the expression of a nervous disease, I cannot help remembering the fact that although our knowledge of glaucomatous ophthalmia is very old, and numerous experiments have been made to find the actual seat of the inflammation, the latter could not be indubitably determined, and further, that the microscope and ophthalmoscope have not furnished any clew to this important subject.

V. Graefe says that the iris is always inflamed in cases of glaucoma, and mentions as a proof the opacity of the aqueous humor and the existence of deposits on the posterior surface of the cornea.† As regards the opacity of the aqueous humor, I will only state that neither myself nor Schweigger‡ could ever convince ourselves of its presence. But I may remark that I have repeatedly seen that the pupil became decidedly clearer after the escape of the aqueous humor, as stated by v. Graefe. I never saw the deposits on the posterior surface of the cornea, and I may add that they must be very rare, as it is well known that the deposits upon the membrane of Descemet disappear very slowly. It is, therefore, not probable that they are overlooked in cases of glaucoma. I have convinced myself that the iris is sometimes conspicuously stiff, as emphasized by v. Graefe; but, based on this alone, we are not justified in speaking of the existence of an iritis. For while in iritis we find, on the one hand, the pupil contracted, the iris not readily or not at all dilatable by atropine, synechiæ, pupillary exudations, hypopyon, and furthermore a tendency to an increase of the inflammatory process after iridectomy, we meet, on the other hand, in cases of glaucoma, with an abnormally large pupil, entirely devoid of synechiæ, responding promptly to atropine, and never closed by an exuda-

* Pathologie und Therapie der Sensibilitäts- und Motilitäts-Neurosen, 3. Auflage, p.47.
† Arch. f. Ophth., iii., p. 478.
‡ Lehrb. d. Aughlkde., 3. Aufl., p. 519.

tion; and furthermore, that the reaction of the iris following the traumatic irritation caused by iridectomy is the same as in the healthy tissue.

The chief argument for accepting the existence of a choroïditis is based by v. Graefe on the invariable presence of an opacity of the vitreous humor.* I have already mentioned that this does not exist, and as we search in vain for any symptom of a disease in the choroid, there is no reason to accept the existence of a choroïditis. Further, as we never observe any inflammation of the ciliary processes, hypopyon, tenderness of the globe on pressure, or retraction of the periphery of the iris, and as normal ciliary processes can very well be seen after each successful iridectomy for glaucoma, we are not justified in speaking of inflammation of the uvea or any of its parts.

The statement made by Donders, that the increase of tension in the glaucomatous eye may precede the inflammation, and reach its highest degree unaccompanied by any noticeable inflammatory symptom, was confirmed everywhere. But we constantly find increased tension and an exquisite excavation in another disease, without any symptoms of inflammation; nay, we find it under circumstances that disclose to us, with the greatest probability, the real cause of the increased tension. I refer to megalophthalmus.

During the past year I observed this condition in a boy 15 years of age. He stated that his disease began four years before, and manifested itself by steadily increasing impairment of vision of both eyes, associated with pain in the eye or head. On examination I found amaurosis of the right eye. He read Jaeger No. 9 slowly with the left eye, and No. 7 with difficulty. The corneæ were perfectly transparent; their vertical and horizontal diameters measured thirteen millimetres, and their sensibility was normal. The chambers were deep; the pupils round, large, readily contracting; the lenses entirely normal; the vitreous body was perfectly transparent, the papillæ were deeply excavated to their margins, and of a beautiful green color. A very distinct arterial pulse was found in the left eye, and could be followed beyond the borders of the papilla. The choroidal vessels could be seen plainly everywhere, as there was very little pigment in the epithelial layer of the almost white-haired boy. The

‡ Archiv f. Ophth., iii., 2, p. 479.

pigment contained in the stroma of the choroid was very sparingly present. The tension of both globes was considerably increased.

Here again we had to deal with an increase of tension and a typical excavation, produced without a trace of inflammation. As in all cases of hydrophthalmus hitherto observed, increase of tension and excavation were found, and the uniform tension of the sclera and cornea cannot be considered a consequence of increased pressure, because we do not meet with ecstasiæ of the sclera, even after a prolonged existence of glaucomatous pressure; as long as the sclera is not in a diseased state, we have to consider the increase of intraocular pressure as a consequence of the distention.

If there is only a distention of the posterior part of the globe, as is the case in staphyloma posticum Scarpæ, an increased tension will not be produced; on the contrary, experience teaches us that persons suffering from a higher degree of myopia have a relative immunity from glaucoma. Nor does the existence of an equatorial scleral staphyloma cause increased tension; and the same may be said of corneal staphylomata, which do not occupy the margin of the cornea and are not combined with anterior synechiæ. The same statement applies also to keratoconus. According to Muralt, signs of increased tension and its destructive consequence, *i.e.*, excavation of the papilla, are wanting in cases of megalo-cornea.* On the other hand, increased tension is never wanting in cases of (total) corneal staphyloma, where the scleral zone adjacent to the cornea is distended, and the diameter of the sclero-corneal ring is increased, and when after phthisis corneæ without marked ectasia of the cicatrix, the sclero-corneal margin is widened; in short, whenever a total uniform or non-uniform staphyloma of the anterior scleral portion has occurred. But increased tension does not occur invariably when a circumscribed part of that zone becomes ectasic, or when the iris has healed in a partial corneal staphyloma. In the same way in which an increase of tension is produced, by distention of the corneo-scleral border in eyes that have acquired ectasiæ in consequence of inflammatory processes, just so does distention

* Muralt, Ueber Hydrophthalmos Congenitus. Dissert.

of the corneo-scleral margin cause an increase of tension in cases of hydrophthalmus.

In megalocornea there is no increase of tension, as is the case in megalophthalmus, for in the former instance the sclerotic is well defined towards the cornea, the widening of the corneo-scleral margin is wanting, and the ectasia is strictly confined to the former membrane.*

It follows from what has been stated that the distention of the scleral tissue cannot be the cause of the increase of tension, but that it may produce such increase by traction upon the ring from which the iris arises. Such traction, as it seems to me, is almost always followed by increased tension. Thus it is evident why anterior synechiæ, that are fixed in ectasic corneal cicatrices, so frequently cause an increase of tension, while posterior synechiæ, not completely preventing the communication between the anterior and posterior chambers, do not have a similar influence. The same is the case in complete circular synechiæ as long as the iris remains in its plane. In the latter cases, however, increase of tension follows as soon as an exudation takes place behind the iris, as a result of a new iritis, which exerts traction upon the ciliary origin of the iris, and causes it to bulge towards the cornea.

But if we turn our attention to the unquestionable inflammations of the tunics of the eyeball or of their contents, which cause a more or less copious accumulation of cellular elements in the tissues, we shall find that their influence upon the tension of the eye, if at all demonstrable, leads to results opposed to those observed in glaucoma. I have very frequently found persistent and considerable diminution of ocular tension, and only exceptionally an increased hardness of the globe. Only in cases of purulent hyalitis and panophthalmitis the globe often becomes as hard as bone. Finding on the one hand an extraordinary hardness of such eyes, even after spontaneous rupture of the capsule of the globe and evacuation of the lens, also after ulceration of the cornea, and having been taught by anatomical examinations what degree of firmness the infiltration of the newly formed tissues deposited on the sclerotic and the fasciæ of the eye may

* Quotation from Manz in Handb. der Gesammten Aughlkde., Von Graefe und Sämisch, ii., 1, p. 139.

retain, I came to the conclusion that this hardness is principally, if not entirely, due to the thickening of the tunics of the eyeball.

Experience teaches us that increased pressure is not rarely found in non-inflammatory affections of the eyeball, but only exceptionally, if at all, in manifest inflammatory conditions. We find, furthermore, that increased tension, as a symptom of glaucoma, occurs very frequently without inflammation. Still we must not overlook the fact that during an attack of so-called glaucomatous inflammation, the intra-ocular pressure rises to an enormous height often in a short time, so that the increase of tension, though not entirely caused by glaucoma, is still considerably influenced by it. We must therefore first try to find the cause of the increase of tension in cases of non-inflammatory glaucoma, and then proceed to the solution of the question why this cause is stimulated to increased action by glaucomatous ophthalmia.

Based on very important reasons, Donders has referred the cause of the increase of tension to an irritation of the secretory nerve of the eye, which, according to his view, is most probably the trigeminus.* The results of the experimental investigations of von Hippel and Grünhagen are in the highest degree favorable to this view,† which, however, is directly contradicted by the results of the experiments performed by Adamük.‡ He finds the cause of the increase of tension in a disturbance of the circulation, consisting in a stagnation of the venous blood caused by a diseased condition of the sclerotic. This is also Stellwag's view. Prior to the publication of these views, Coccius, supported by anatomical investigations, had stated that in cases of glaucoma the sclerotic becomes harder and less elastic, and that this is the cause of the increase of tension.

As the results of the physiological experiments are so contradictory, we must seek help from our clinical material. It is impossible to decide whether a demonstrable and suddenly occurring increase of tension is due to an irritation of the secretory nerves, or to a disturbance of the circulation from any cause.

But we can recognize the cause of a sudden diminution of ten-

* Arch. f. Ophth., viii., p. 162. Klin. Mon.-Bl. f. Augenheilkunde, 1863, p. 503, und 1864, p. 433.

† Klin. Mon.-Bl. f. Augenheilkde., vi., p. 384, und vii., p. 374.

‡ Klin. Mon.-Bl. f. Augenheilkde., vi., p. 384, und vii., p. 386.

sion in cases where the capsule of the bulb has not been opened. This will probably enable us to solve the problem of the increase of tension. Sudden and extreme diminution of tension occurs in cases of detachment of the retina and essential phthisis of the globe. Von Stellwag makes the following remark: "The diminution of the palpable tension of the bulb is one of the ordinary phenomena occurring in cases of detachment of the retina."* Von Graefe says, in regard to the state of the ocular tension in cases of detachment of the retina: "Diminution of the ocular tension is the rule; sometimes, however, the tension remains within physiological limits for a long time."† *But diminution of the intra-ocular pressure is the cardinal symptom of detachment of the retina, and the process which causes this symptom also produces the detachment of the retina.*

The latter is generally looked upon as the mechanical consequence of an exudation occurring between the choroid and retina. But as the capacity of the globe is limited, the sclerotic yielding only very little, and the intra-ocular fluids being incompressible, we can only imagine that the exudation occurs very slowly, causing by its pressure an absorption of a part of the vitreous body. Then a little more fluid exudes, and this in turn causes a further absorption of the vitreous body, and so forth. In this way the slow growth of a tumor between the tunics of the eye may be explained. But experience shows that a detachment of the retina occurs suddenly, and we cannot conceive how the exudation could remove such a large quantity of vitreous humor in so short a time, unless the pressure by which the exudation takes place be sufficiently powerful to cause a rupture of the retina. If the detachment of the retina would slowly increase in the way described above, we should expect to find at least a normal, most probably an increased tension, as is the case in intra-ocular hemorrhages and tumors. But the fact is that there is a very decided diminution of tension even in quite recent cases of detachment. We might perhaps try to explain it by assuming that a greater quantity of vitreous humor was absorbed necessary to make room for the suddenly occurring exudation. But why is it that the equilibrium is not re-established, as is the case when large

* Der intraoculare Druck, etc., p. 56. † Archiv f. Ophth., xv., 3, p. 172.

quantities of vitreous humor are lost by traumatic causes? why does not the pressure rise above the normal height when the normal secretion of vitreous fluid recommences, as one would expect, from the increase of the contents of the eyeball? and reversely, why does the exudation not disappear in consequence of the pressure exerted upon it by the vitreous body? why does the tension remain at the same infra-normal height for months or years, until it finally equalizes itself?

There is only one answer to all these questions. The diminution of the vitreous body exceeds by far the quantity that was necessary to disappear in order to give room to the exudation; it preceded the separation of the retina, and the disturbance that caused it continues.

The exudation behind the retina is secondary; it is the consequence, and not the cause. The separation is the mechanical consequence of the diminished tension, just as the excavation of the papilla is the consequence of increased tension.

Mauthner emphasizes that there are great and at present "perhaps insurmountable difficulties," to explain the cause of the detachment of the retina in cases where there is neither traction by cicatricial bands, nor a perforation of the globe. "In cases of myopia of a very high degree, the distention of the tunics of the eye may be so considerable that the retina can no longer remain in contact with the choroid. Besides this, an inflammatory process of the choroid will favor the occurrence of exudation. But this does not explain the occurrence of detachment, if we consider the conditions preceding the separation."

The existence of a detachment in other cases where we either really see signs of retinal inflammation, or try to see them for our purpose, is stranger yet; for of what value are the most favorable circumstances for the occurrence of an exudation, if there is no room for it, if the posterior part of the eye is filled by an incompressible body—the liquefied vitreous body. In such cases we must necessarily assume that a part of the vitreous body was absorbed in a way not entirely known to us, and that—(natura horret vacuum)—a subretinal exudation occurred.*

We see, therefore, that there exists a contrariety in the con-

* Lehrbuch der Ophthalmoscopie, pp. 394 and 395.

ditions of detachment of the retina and glaucoma, though according to a very prevalent view the choroid is the principal seat of both diseases, the subretinal fluid as well as the increase of the fluid of the vitreous body being thought to be caused by a choroidal exudation. This view does not explain why the exudation accumulates behind the retina in the one case, and enters the vitreous body through the retina in the other; why in one instance the tension is diminished in spite of the apparent addition of a quantity of fluid, while in another the tension is increased without a perceptible increase of the contents of the globe. If we furthermore accept this view, we are forced to assume the existence of choroïditis in cases where it cannot be demonstrated, or where it can be proven not to exist at all, as for instance, in numerous cases of glaucoma.

Clinical observation offers the indubitable proof that the decrease of tension in cases of detachment of the retina is produced by a sudden diminution in the quantity of vitreous humor.

November 8, 1872, I made the acquaintance of a patient who presented himself on account of a sudden impairment of sight of his highly myopic right eye. The globe was so soft that it wrinkled during its movements. The anterior chamber was of enormous depth, the surface of the iris perceptibly concave, the iris and lens were tremulous. It was even noticed by the patient that the formerly projecting globe had sunken in deeply. I had previously seen such a condition of things in eyes that had sustained a perforating wound of the sclerotic, and I supposed that in the present case the highly attenuated wall of the staphyloma posticum had burst and given issue of the contents of the eyeball into the orbit. But after two days the sight of the patient, which had been reduced to quantitive perception of light, returned. With the ophthalmoscope we could demonstrate that the detached retina had reattached itself. The eyeball then had regained its normal shape and tension. The tension was normal on November 28th, the chamber more shallow than usual in cases of high degrees of myopia, the iris no longer tremulous. As this case, the farther history of which is of no interest here, gave me a clew to solve the question how separation of the retina occurs, I observed the ocular tension in all similar cases, and I can now lay down the rule that in all recent cases of separation of the retina there is a diminution of tension, produced by a considerable decrease of the amount of vitreous humor. Certainly one does not err in assuming, previous to the ophthalmoscopic examination, the existence of a separation of the retina in an

eye that has suddenly lost its sight and tension without being the seat of inflammation.

The prominent complaint of a contraction of the visual field will prevent us from mistaking it for essential phthisis. In by far the greatest number of cases, the diminution of tension is very marked, and the sense of touch is very reliable here, though it gives us only uncertain information in determining the increase of tension in cases of glaucoma. Furthermore, the examiner can see the effect of the digital pressure, in cases of separation of the retina, for even by slight pressure on the globe, the corresponding pupillary margin becomes stretched, and the pupil assumes the shape of an elliptical slit. Repeatedly I have seen oscillations of the iris with the naked eye, and for some time also those of the images of the lens, by illuminating the eye with the mirror at a time when the eye was at rest after having been moved rapidly several times. But normal tension existing at the time of examination does not definitely exclude a recent separation of the retina.

I have a patient now under observation who, having lost the sight of his right eye 1½ years previously by a spontaneous separation of the retina, suffers from the same affection of the other eye in consequence of a blow upon the left side of the head. He received this blow June 29, 1875, at 8 P.M. The patient's vision was much impaired on the 1st of July, but, according to his statement, there was no contraction of the visual field. This contraction is said to have occurred on the 2d day of July. I saw the patient for the first time on the 3d of July, and found a detachment of the upper and inner part of the retina. The vitreous body was clear, and there was normal tension of the globe.*

The color and entire appearance of the separated parts did not suggest subretinal hemorrhage. On the 7th of July a very considerable diminution of tension occurred, and then the globe presented the appearance characteristic of a perforating wound of the sclerotic. These features are very much marked in eyes with recent separation of retina, as previously mentioned, but are lost again after some days, when the chamber

* This case gives very great support to the statement previously made as to the manner of occurrence of retinal detachment. The sudden loss of the vitreous body was followed by such an abundant exudation that no alteration in the tension could be noticed. But this alteration did occur after a short time, without any further separation, proving the continued activity of the force that had produced the first loss of vitreous fluid, though it did not cause any further separation.

will be found frequently even more shallow than normal. On the 9th of July the entire superior half of the retina had separated and there were numerous floating opacities in the vitreous body. The diminution of tension still existed in the beginning of August.

I know a case where even now, *i.e.*, two years after the occurrence of the separation of the retina, there is a great diminution of tension, and where by mere inspection of both eyes at a distance, the one whose retina is detached attracts attention by its comparative smallness and retraction. In the majority of cases, this anomaly of tension, as far as my experience goes, disappears after existing for several months. After extractions of cataract, I have been repeatedly surprised by the existence of retinal detachments of unknown age that had announced themselves by a diminution of tension neither before nor after the operation. Such separations present to the opthalmoscopist a picture differing somewhat from the ordinary one, the oscillations of the retina being wanting. I formerly believed that a subretinal tumor existed when the retina was tense and the ball of normal hardness. But I am convinced now that this is not necessarily the case in order to produce such a picture. During the existence of diminished tension I frequently observed changes in the degree of tension, though there were no corresponding alterations observed in the separated retina. In a patient who was under my care for five months, and whose ocular tension was very much lowered, I observed twice that the tension returned temporarily to the normal standard. It occurred both times during a severe attack of diarrhœa with fever. The influence of the increased pressure of the blood upon the intra-ocular pressure was thus shown in a beautiful way.

It follows undoubtedly, from what has been stated, that the decrease of tension in cases of separation of the retina is produced by a sudden actual diminution in the quantity of vitreous humor. It being proven that a primary anomaly does occur, consisting in a diminution of the quantity of vitreous humor, we may also accept it as a fact that an anomaly may exist, consisting of the reverse conditions. The paroxysmal occurrence of increased tension in cases of glaucoma, accompanied very frequently with intense pain, turbidity of the cornea, and injection of the episcleral vessels, has its perfect analogy in the case of essential

phthisis described by v. Graefe,* and in the above-mentioned case of v. Hippel, where a severe pain in the course of the trigeminus was accompanied by a slight opacity of the cornea and shallowness of the anterior chamber, diminished consistency of the globe, very marked injection of the conjunctival and subconjunctival vessels, sensitiveness to light and the appearance of a cloud descending in front of the eye.† Detachment of the retina and essential phthisis are only different manifestations of the same disease.‡

Detachment of the retina occurs apparently more frequently than essential phthisis. Nagel was the first to mention distinctly that in cases of different kinds of inflammations, hypotony occurs very frequently, not directly depending on the inflammation.§ I have perfectly convinced myself of the correctness of this statement, and if the neuropathologists would turn their attention to this point, I do not doubt but that they would be able to give us remarkable information. It depends upon special con-

* Ueber essentielle Phthisis bulbi, Arch. für Ophth., xii., 2, p. 256.

† L. c., p. 53 und 54.

‡ In one case the near relation of these two forms of disease became evident to me in an exquisite way, for I was not able to determine whether I had to deal with the one or the other. As the patient was suffering from cataract and a pre-existing amblyopia, we could not derive any conclusions from the examination of the visual field. It was a patient on whom extraction had been performed on the left eye, January 23, 1875. When the dressing was removed on the 29th of January, it was found that the healing process in the eye operated on was very favorable, but that in the right eye a great loss of tension had occurred. I do not recollect ever having met with such a degree of softness in an unopened, non-phthisical eye. The cornea was transparent; around it was a dense ciliary injection; the anterior chamber very deep, the iris tremulous, the pupil dilated and diagonally oval. There existed neither spontaneous pain, nor was the eyeball tender on pressure. The light of a small wax candle was distinctly recognized at a distance of one and a half feet, and correctly localized. In the left, operated eye, normal tension existed. January 30th the tension had somewhat increased in the right eye, and the pupil was contracted. On the 1st of February a slight increase of tension was again noticed, the chamber had become more shallow, and the injection had disappeared. On the 15th of February the tension, though still low, had somewhat increased. The iris had ceased to be tremulous. The light of a lamp was promptly perceived at a distance of five feet in the lower half of the visual field, and hardly at one foot in the upper. February 27th the tension was yet considerably under the normal standard, and the anterior chamber still shallow. On March 1st the tension was almost equal to that of the left eye. The patient left the hospital March 13th. The tension of the right eye was then only slightly under the normal standard; the anterior chamber strikingly shallow; the light of a lamp was seen in all parts of the visual field at a distance of four feet.

§ Ueber vasomotorische und secretorische Neurosen des Auges, Klin. Mon.-Bl. f. Augenheilkundel, xi., p. 394.

ditions existing in an eye which is the subject of a sudden diminution in the quantity of vitreous humor, whether that anomaly will cause detachment of the retina or essential phthisis. Eyes with large posterior scleral staphylomata are well known to contain a large quantity of fluid, even when the consistency of the vitreous body is normal.* They are often the seat of synchysis corporis vitrei, and have a sclerotic the elasticity of which has been used up. Therefore, on the one hand, a large quantity of the fluid may disappear as soon as the cause producing the diminution of the contents of the globe begins to operate; and, on the other hand, the sclera cannot contract around the diminished contents of the eyeball. The consequence is that from the choroidal vessels, so suddenly relieved of their intra-ocular pressure, a transudation occurs.†

We know that the anomaly of tension may exist for months and years in cases of detachment of the retina and glaucoma, and a return to the normal standard may occur quite suddenly. We also know that a loss of vitreous or aqueous, due to a traumatic cause, is rapidly replaced, and that, exclusive of some of the sources of secretion, even removal of the entire iris or extensive destruction of the choroid does not produce any diminution of the contents of the globe. We are aware of the fact that an absolute increase of the quantity of the contents of the globe does not result from an accelerated secretion or increased production, and that, on the contrary, the normal equilibrium between secretion and excretion is soon re-established after such temporary disturbances. If, then, we take into consideration that in cases where the vitreous body is completely filled with floating bodies, and where the most complete saturation of the tunics of the eye with plastic material exists, the intra-ocular tension is not only not

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* Vergl. v. Alt., Die Krankheiten des Auges, III. Bd., p. 17.

† Having accepted this view of the mechanism causing detachment of the retina, the question arose as to whether it was not useful to combine puncture of the retina with an injection of fluid into the vitreous body, or even to abandon the former procedure and practise the latter. I was therefore very much surprised to read in v. Arlt (Handbuch der ges. Augenhlkde. von v. Graefe und Saemisch, iii., 1, p. 372) that Weber cultivated a method of operating that was probably based on the same idea which I had formed. I gave up my intention before I had tried it, for I had to acknowledge that an injection of fluid into the cavity of the globe could not have any other effect than paracentesis of the anterior chamber has in cases of glaucoma.

increased, but very frequently even diminished, it becomes evident that we cannot deduce the anomaly of tension in cases of glaucoma and detachment of the retina from an increased secretion or absorption.

In cases of detachment of the retina and glaucoma there is a disturbance of the equilibrium of secretion and absorption of the intra-ocular fluids. In these diseases the equilibrium is re-established under conditions that are dangerous, nay, even destructive to the functions of the eye as a physical apparatus, and likewise to the vitality of the tunics of the eyeball. *The regulation of the conditions of secretion and absorption, the compensation in cases of accidental disturbances, belongs to the domain of nervous action, and a disturbance of this action must be looked upon as the cause of the permanent increase of the vitreous humor in cases of glaucoma, and of the permanent diminution of this fluid in cases of detachment of the retina and essential phthisis.*

It suffices to refer to facts unanimously adopted by ophthalmoscopists and observed every day, in order to show that the course of the anomaly of tension in cases of glaucoma has the character of a purely nervous disease. At all periods of the course of this disease the anomaly of tension holds pace with the opacity of the cornea and the glaucomatous pain. They all appear and disappear suddenly, and have paroxysms of sometimes a typical character.

By proving the similarity of the origin of glaucomatous ophthalmia and the anomaly of tension, we also solve the question why the ophthalmia increases the tension. Irritability of the sensitive nerves is not necessarily connected with a similar state of the secretory nerves. Each one of these conditions may exist separately, or may be combined with various degrees of irritability of the other. But it seems to be the usual relation that a considerable irritation of the sensitive nerves is associated with an irritation of the secretory nerves of the same intensity.

The anæsthesia of the cornea is generally explained by pressure exerted on the sensitive nerves passing through the interior of the eye to the cornea. But aside from the impropriety, as yet not sufficiently regarded, of explaining the pain or irritation of the sensitive nerves, and also the anæsthesia or paralysis of the same nerves by a pressure acting on all nerves of the eye with

the same intensity, and during the same period, we must also bear in mind that the cornea retains its normal sensibility in cases of glaucoma simplex, even when the eyeball attains its highest degree of hardness, or, in cases of hydrophthalmus, where strong traction is added to increased tension, while partial or total insensibility of the cornea is found after one or more attacks of ophthalmia, whatever the pressure may be. I therefore believe that we must regard the anæsthesia of the cornea as a consequence of the neuralgia of the sensitive nerves, and to show this I refer to the description of the nutritive disturbances of the eye, observed by v. Hippel in cases of disease of the trigeminus. V. Hippel relates the history of a woman entering the clinic with anæsthesia of the entire left side of the body; from there it gradually extended over the right side. The partial anæsthesia of the right trigeminus developed in the following way: Intense pain following the course of the individual branches, spontaneous hemorrhages beneath the conjunctiva bulbi or from the ear; then total anæsthesia in the region of the painful branches; finally, a gradual restoration of sensitiveness. These phenomena were repeated 8 to 10 times, but the sensitiveness of the parts supplied by the first two branches of the trigeminus became diminished after each new attack." *

Not only the anæsthesia of the cornea, but also mydriasis, is wanting in cases of glaucoma simplex and hydrophthalmus. The width and mobility of the pupil corresponds on the whole with the condition of sensitiveness of the apparatus to luminous impressions. But with the first inflammatory attack maximum mydriasis is sometimes found associated. V. Graefe emphasizes the statement that a higher degree of mydriasis exists in cases of glaucoma than can be accounted for by the paralysis of the fibres of the oculo-motorius which supply the sphincter alone, and he further states that maximum dilatation occurs only with progressive atrophy of the tissues." † But v. Graefe himself relates a case of glaucoma fulminans, where the disease began December 16th, and maximum mydriasis was found on the first of January.‡ From Wegner's and v. Hippel's statements we learn that extreme my-

* L. c., p. 52 and 53.
† Archiv f. Ophth., i., 2, p. 306, and iii., 2, p. 465.
‡ Arch. für Ophth., viii., 2, p. 25c.

driasis does occasionally occur with every paroxysm of neuralgia of the trigeminus, also without increased pressure. With regard to the fact that the mydriasis occurring in cases of glaucoma is not directly proportional to the increase of tension, but corresponds with the attacks of glaucomatous ophthalmia in its onset as well as also in its degree of development, I believe that the mydriasis is not the direct consequence of the increase of the intra-ocular pressure.

Nor does the shallowness of the anterior chamber correspond with the degree of the increase of tension. This symptom (shallowness of the anterior chamber) also is not very prominent in cases of glaucoma simplex, even when the eyeball has attained its greatest hardness, while it is never missing in cases where a glaucomatous inflammation has existed for any length of time. I cannot explain how this ophthalmia could produce an increase of fluid in the posterior cavity of the globe, and at the same time a diminution of fluid in the anterior chamber. It seems not at all improbable that the form of the lens may be influenced by the glaucomatous inflammation, which is known to produce constantly the greatest changes in the tissue of the lens. In this way we could account for the diminution of the anterior chamber.

In a large number of cases total excavation with steep margins is solely produced by increased tension, but occasionally it seems to be caused also by the co-operation of other causes. In cases of secondary glaucoma, where the deepest excavations are often found, we can only seek the cause in the increased tension. The occasional disappearance or diminution of an excavation after iridectomy, demonstrating most perfectly the dependence of the excavation upon the increased tension, was first pointed out by v. Graefe.* Considering that occasionally the optic nerve does not become excavated in spite of a great and long continued increase of intra-ocular pressure,† while the deepest excavations are found in cases where the increase of pressure was doubtful,‡ it becomes difficult to reject the supposition of an occasional occur-

* Arch. f. Ophth., iv., 2, pp. 137 and 140.

† See v. Graefe, Arch. für. Ophth., xv., 3, 232 und 233; Mauthner, Lehrb. der Ophth., p. 281; Rydel, Arch. für Ophth., xviii., p. 7; Mooren, Ophth. Mitth., 1874, pp. 52 und 53.

‡ Alfred Graefe, Arch. f. Ophth., vii., 2, p. 313; Mauthner, Lehrb. der Ophth., p. 282; v. Graefe, Arch. f. Ophth., xv., 3, p. 180.

rence of excavation caused by an independent disease of the optic nerve. V. Jaeger lays stress upon "the frequent occurrence of an excavation without a demonstrable increase of tension," * and says further: "The diminution in the resistance of tissues, and not the normal or increased pressure, are the direct cause of the ectasia." † According to Coccius, the tension is so slight in many cases of glaucoma, that it is not sufficient to cause the principal symptom of glaucoma.‡

For a time v. Graefe was tempted to accept the view that normal pressure was sufficient to produce excavation if the papilla has lost its power of resistance. Subsequently he was convinced that there was nothing in favor of such a supposition. Nevertheless, he mentions the possibility of a giving way of the lamina cribrosa at the optic nerve, *under the influence of a peculiar disposition*, by a gradual increase of pressure, while the nerves supplying the iris, ciliary muscle, and cornea retain their conducting power, and the reflux venous blood in the posterior parts of the eye remains unchanged. § Mooren speaks of cases where "a pure excavation of the optic nerve was not associated with an increased hardness of the globe." ‖ According to Adamük, the increase of intraocular pressure is not sufficient to cause an excavation, and we must accept a nutritive disturbance existing in the lamina cribrosa. ¶ The so-called glaucomatous ring around the papilla generally found in cases of glaucoma simplex seems to militate in favor of the existence of an independent disease located in the lamina cribrosa, and in the parts of the choroid surrounding the optic nerve. We do not find such a border in other diseases of the optic nerve, neither can we explain it by the influence of the increased intra-ocular tension, nor by the traction produced by the receding lamina. The latter cannot be accepted, for the ring is in no proportion to the depth of the excavation and the rapidity of its development. We sometimes find the ring of considerable breadth, when we are not even sure of the existence of the excavation. As it seems to me, it is rarely found in cases

* V. Jäger, Ueber Glaucom und seine Heilung durch Iridectomie, Wien, 1858, p. 18.
† L.c., p. 19. ‡ Arch. für Ophth.
§ Arch. für Ophth., viii., 2, pp. 277–279.
‖ Ophth. Mittheil., 1874, p. 51.
¶ Klin. Mon.-Bl. für Augenheilkunde, v., p. 328.

of secondary glaucoma where the excavation is the effect of pressure simply, while it is rarely wanting in cases of glaucoma simplex. The perfect development of the excavation always found I also regard as being in favor of the existence of an independent disease of the lamina cribrosa. The bottom evidently being the most yielding portion in the physiological excavation, it seems strange that the increased pressure does not operate on it first, but rather on the peripheral parts of the papilla. V. Graefe holds that the physiological becomes the starting-point of the glaucomatous excavation, so that for a time the excavation is neither total, nor does it present its other characteristics.* Such a process is certainly not the rule. I have never observed it. But, very frequently in the beginning of the glaucomatous process, I have noticed a deepening of the margins of the papilla which was the seat of a physiological excavation. The margins of the pre-existing excavation did not lose anything of their distinctness, and the unchanged normal excavation was found to be situated in another excavation.† Even where we are perfectly justified in regarding an existing glaucomatous excavation as being of recent date, we almost always find it occupying the entire papillary area and gaining only in depth during its further development. A partial glaucomatous excavation is only exceptionally found, but even then the excavation extends to the margin of the papilla. I have never seen a glaucomatous excavation which at any period of its existence did not extend to the margin of the papilla.

If we should succeed in proving the existence of an independent disease of the lamina cribrosa in glaucomatous eyes, we should have to find the connection existing between this disease and that observed in the anterior portion of the globe. Their co-existence is certainly not a mere accident, as is already shown by a case reported by Alfred Graefe, where an exquisite excavation had developed without any increase of tension or other glaucomatous symptoms ; the latter appeared after the excavation had existed for a considerable length of time.‡ I observed the occurrence of a glaucomatous excavation without an increase of pres-

* Arch. für Ophth., viii., 2, p. 283.

† See v. Jäger, Ophthalmoscop. Handatlas, Taf. xii., Fig. 60.

‡ Arch. für Ophth., vii., 2, page 113.

sure, subsequent to the cure of an acute glaucoma by a skilfully performed iridectomy.

The case occurred in a patient fifty-three years of age, on whom iridectomy was performed at the Ophthalmic Division of the General Hospital, on February 4, 1870, on account of acute glaucoma. One day after the operation her other and hitherto healthy eye was attacked by the same disease. First, the patient refused to have an operation performed, and it was therefore delayed until the 8th of February, *i.e.*, four days after the beginning of the disease. The operation performed upward answered all requirements, and was successful in every respect. The papilla was moderately reddened and on the same level with the retina. The frequently repeated ophthalmoscopic examinations always demonstrated the want of a glaucomatous excavation. On April 8th I found a perfectly characteristic glaucomatous excavation, although there was no change in the sight, no increase of pressure, and no other additional glaucomatous symptom.

This case—unique, as far as I know, in ophthalmological literature—is a most important supplement of that reported by Alfred Graefe. In cases of glaucoma we almost always find increased pressure and excavation co-existing, and wherever we are able to observe the succession in which these symptoms are developed, we find, without exception, that the increase of pressure preceded the excavation, and might be regarded as its cause. But the excavation developed previous to the increase of pressure in Graefe's case, and in mine subsequent to the removal of the increased pressure. *Both were glaucomatous excavations, at least as regards their form and appearance, though they were not produced by pressure.*

Only in the very rarest cases we are able to make such a distinction, and we should, therefore, all the more not annihilate the value of such precious cases by accepting the existence of an increased pressure where the latter is not found, and support a theory capable of improvement. Nor is it justifiable to ascribe the visible effect to a power which could not have existed, as demonstrated by the other conditions found on examination. Although I perfectly agree with Graefe that the case described by him is intimately related with the group of glaucomatous diseases, I cannot at all subscribe to his statement that the excavation ob-

served stands in the same relation to the influence of the intra-ocular pressure as glaucomatous excavations generally.

Total excavations with steep borders, unquestionably glaucomatous in character, but not caused by increased pressure, as shown by the mode of their production, were observed by Mauthner* and v. Graefe.† Exquisitely developed excavations were associated in these cases with only slightly marked glaucomatous symptoms; but they are sufficient to show that the excavations were signs of a glaucomatous disease, while the marked disproportion between the degree of pressure and the depth of the excavation does not admit the inference that the excavation was the result of pressure.

Finally, we must notice the fact that there are *total excavations with steep margins, neither glaucomatous in their character nor caused by an increase of pressure.*

In a case where the ophthalmoscope revealed excavation of a glaucomatous appearance as the only symptom of glaucoma, Schmidt‡ was enabled by the anatomical examination to demonstrate that atrophy was the cause of the apparent excavation of the optic nerve. This case conveys a very significant lesson, which, at the conclusion of his essay, he expresses in these words: "In view of our communication, many cases in which the diagnosis of glaucoma simplex has been based simply and solely upon the presence of a pressure excavation, and in which iridectomy is fruitless, must now find another and satisfactory explanation."

For the sake of completeness, I will add that the high degree of visual imperfection in acute glaucoma must not be regarded as necessarily and exclusively an immediate or mediate consequence of increased pressure. For the contributions of Wegner and v. Hippel have taught us in no doubtful terms what an enormous lesion of the visual function may occur in connection with neuralgia of the trigeminus and without any other changes in the eye; and thus the presumption is allowed that a part of the disturbance of vision during an attack of glaucoma is very probably due to causes other than the increase of pressure.

So, for us, increased pressure loses its importance as a funda-

* Lehrb. der Ophth., p. 282. † Arch. für Ophth., xv., 3, p. 180.
‡ Arch. für Ophth., xvii., 1, p. 117.

mental symptom of glaucoma. It is not the trunk from which branch out the other symptoms. Despite its controlling influence upon the functional integrity of the eye, it is a symptom only co-ordinate with others. The knowledge of the material changes whose functional expression is the pathological increase of pressure is therefore of less moment than a knowledge of the essence of glaucoma.

The individual symptoms of glaucoma appear in such different sequences, and are combined in various degrees of development to form such different scenes, that the like is not found in any other disease. Among the symptoms, increased tension is the most constant; it is often the first, and sometimes the only; with it the danger increases, and its long persistence is usually accompanied by irremediable injury to the eye. But as not every increase of tension means glaucoma, so also we are not necessarily obliged to wait for increased tension before declaring such or such a case to be one of glaucoma. Mina Dankhof had glaucoma six years before the tension of the ball was exaggerated; the sequence of symptoms in her case was rather unusual.* So it was tardy in Wegner's case, and in mine, where an attack of neuralgia opened the scene. In my opinion, it is a mistake to date the glaucoma only from the beginning of increased tension, although this gives the first urgent indication for iridectomy, and hence authorizes the erection of a prodromal stage, in reference to the treatment. We have indeed been told of cases in which excavation of the optic nerve was the first symptom of glaucoma? There are also prodromal symptoms, discoverable only by means of the ophthalmoscope, in the part of the nerve and its vicinity. Adamük† believes that he has found changes preceding the papillary excavation, and my observations render the existence of such very probable; but I have hitherto been unable fairly to convince myself in this direction, and can therefore regard as prodromic in the region of the papilla only the formation of a glaucomatous excavation, in the absence of all other glaucomatous symptoms. (Alfred Graefe's case).

However varied may be the phenomenal forms of glaucoma, they have a common nature. Often enough the only distinction

* V. Graefe, Arch. für Ophth., iii., 2, p. 520.
† Klin. Mon.-Bl. für Augenhlkde., v., p. 328.

between glaucoma simplex and glaucoma complicatum is quantitative; we mark in both the same symptoms, only in different degrees of development. Seldom we find simple glaucoma without now and then slight pains in the forehead and temple, transient slight obscurations and iridescence. When these phenomena are indistinct and easily overlooked, the concurrence of increased tension and papillary excavation is called glaucoma simplex; while a higher degree and greater distinctness of the other symptoms gives occasion to the name glaucoma complicatum. Often a glaucoma does not develop a perfect picture of the disease, for while a part of the symptoms may be distinct enough, others are quite rudimentary or even altogether wanting. If the only sharply defined symptoms are increased tension and excavation, we call the disease glaucoma simplex; but if there be also pain, corneal turbidity, redness, and disturbed vision, we say it is complicated. So we find at the same time qualitative differences between symptoms and a community of nature.

Iridectomy calls forth neither a noticeable inflammatory reaction nor changes the condition of intra-ocular tension, when employed in a relatively normal eye as part of a cataract operation or for the sake of opening a new ingress for the light. Only exceptionally there is a condition of slight irritation which increases to a very trivial inflammation. Heddæus, who for years makes iridectomy preliminary to extraction, without restraining the patient's locomotion, saw an example of perfectly undisturbed healing in the case of an old woman of 70, who had to go miles immediately after the operation.* As long as the wound of an iridectomy is still unclosed, the tension of the globe is naturally below the normal; generally in 6 to 8 days, and always by the 10th to 14th day, the tension is again normal, even when the piece of iris removed is larger than in the regular iridectomy for glaucoma. I have followed the condition of intra-ocular tension after iridectomy in a great number of cases, carefully controlling my results, and have convinced myself that there is absolutely no diminution of tension after iridectomy in the relatively normal eye. Donders† could not discover it; but v. Graefe‡ thought it

* Klin. Mon.-Bl., xi., p. 352. † Arch. für Ophth., viii., 2, p. 174.
‡ Arch. für Ophth., iii., 2, p. 492.

probable that iridectomy of the healthy eye diminished the tension. This opinion is supported by the result of measurements of tension after iridectomy in animal eyes. So Wegner* found, 16 days after removal of about a sixth part of the iris in two rabbits, that the tension of the iridectomized eye was less than that of the normal eye; and v. Hippel and Grünhagen demonstrated the same thing in rabbits, dogs, and cats, where repeated iridectomies had caused the loss of a fourth part of the iris.† Without permitting myself to criticise these experiments, or to object that the results concerning the condition of intra-ocular tension after iridectomy, as obtained by the simple touch, can lay no great claim to accuracy, I believe that I ought to express a decided opinion on the fashion of transferring experimental data from the *animal eye to the human eye. Let the intra-ocular* pressure after iridectomy on the rabbit, with the wound in the cornea, be diminished: that is quite sufficient in order to show how little foundation there is for the assumption that the data obtained from the animal eye are of equal value as to the human eye. For, as everybody knows, iridectomy of the human eye has no influence whatever upon the tension if the wound lies only on the cornea; and upon the absolute necessity of transferring the wound to the sclera, there is but one opinion. The fundamental difference of effect between animal and human iridectomy is still further demonstrated by the fact that v. Hippel purposely made a large section of the iris, and was obliged to iridectomize twice in order to obtain the diminution of tension, while it is well known that in iridectomy of the human eye the degree of diminution does not depend upon the size of the fragment cut from the iris. And I am bound to note that one can hardly avoid a feeling of doubt as to the wide difference of tension observed by v. Hippel, when one reflects upon the inexact method of examination by simple touch. The attempt which Exner has made‡ to explain the modus agendi of iridectomy may be worth something as to the brute eye; but as to the human eye, it is insignificant, because the fact which he endeavors to bring within our comprehension does not exist.

When iridectomy is made in an inflamed eye, it acts as an ad-

* Arch. für Ophth., xii., 2, p. 15.

† Klin. Mon.-Bl. für Augenhlkde., vii., p. 377.

‡ Medic. Jahrbücher d. Gesellsch. d. Aerzte in Wien, 1873, Heft. 1, p. 52.

ditional provocation to the inflammation, and often causes the most deplorable consequences. Hence, all authors caution against it under such circumstances. In eyes where there is a remnant of inflammation, and the normal condition is not perfectly restored, it fans the flame, or is followed by a persistent state of irritation, with an evident diminution of tension, which after a time will end in phthisis.

It would be quite superfluous to adduce cases in illustration of this, and equally unnecessary for me to combat the objection that such consequences do not always follow such an iridectomy, but that now and then such an eye will tolerate the operation.

In a glaucomatous eye, iridectomy removes at once the pain, the corneal cloudiness, and the increase of tension. So, for those who regard glaucoma as an inflammation, iridectomy is an antiphlogistic; and those who regard exaggerated tension as the essential disease, and the inflammation as an accident, will ascribe to iridectomy the power to diminish the tension and to control the inflammation. If then the glaucomatous inflammation, with its increase of tension, be contrasted with all other inflammations, it assumes by its peculiar reaction towards iridectomy such an exceptional position as to stand apart from the inflammatory series, and to appear at least as a disease which is not an inflammation in the true sense of the term. While the behavior of the iris under the injury shows that we are not dealing with an inflamed tissue, since the reaction towards the iridectomy is precisely identical with the reaction in case of iridectomy of the healthy eye, *the instant subsidence of the pain and wonderfully speedy clearing up of the cornea points in an unmistakable manner to the analogy between this result and the termination of a neuralgia by neurotomy.*

In the whole domain of therapeutics, whether operative or medical in the stricter sense, iridectomy finds its nearest analogue in the effects of simple section or resection of nerves. True, v. Hippel * thought he proved that the nerves played no part in iridectomy when he found section of the trigeminus at the basis cranii of a rabbit, followed by no effect upon the intra-ocular tension. Claude Bernard and Donders came to the opposite

* Klin. Mon.-Bl. für Augenhlkde., vii., p. 378.

result in similar experiments, and in cases of trigeminus paralysis there is often a perceptible diminution of tension in the eye of the affected side;* moreover, we must take into account the fact that iridectomy does not cause an absolute diminution of intra-ocular tension. If the healthy eye be iridectomized, the normal tension is unaffected; and when a diseased eye with diminished tension is operated, v. Graefe† has pointed out that under certain circumstances the tension may rise to the normal again; so that it is only in the glaucomatous eye with increased tension that the diminution of tension under consideration is effected. *Hence, we cannot say in general terms that iridectomy always diminishes intra-ocular tension, but rather that it reduces a pathological increase of tension.*

The effect of iridectomy is not a purely mechanical one. We do not unburden the eye by merely diminishing the vascular area; we are not satisfied to retain the cause of the disease after the operation, and stay the morbid process in making its further extension less dangerous by removing with the bit of iris a part of the source of the abnormal secretion. It is well known that after removal of the entire iris the equilibrium is quickly restored and made permanent.‡ Nor should we forget that it is quite immaterial to suit the size of the section of the iris to the degree of the anomaly of tension; that the same size of fragment will answer for quite different degrees of increased tension; that a much larger section than sufficed in one eye with a high degree of tension will not in another eye with only a moderate increase of tension reduce it below the normal; and that in acute glaucoma a clumsy iridectomy may be followed by the best result, while in a chronic case, with much less tension, a faultless operation may be entirely futile. We must therefore seek further for the explanation of the effect of iridectomy in glaucoma; we must even interrogate the organs which regulate the equilibrium of secretion and absorption, and that leads us to the nerves themselves.

And here we find a concurrence of the data furnished by observations upon iridectomy and analyses of glaucoma. As

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* Klin. Mon.-Bl. für Augenhlkde., 1864, p. 436. Hirschberg, Centralblatt für die med. Wissenschaften, 1875, No. 6.

† Arch. für Ophth., ii., 2, p. 219. ‡ Ibid.

might be expected beforehand, the two lines of inquiry started at opposite points meet here, for the question of the nature of glaucoma is identical with the question of the nature of the evil which iridectomy is intended to obviate.

We find the essence of glaucoma to be a neuropathy, and hence the curative action of iridectomy must be directed to this. The iridectomy reaches only those symptoms of glaucoma which are the expression of the neuropathy; and the more pronounced these are, the more brilliant will be the effect of the operation. General experience teaches that the curative effect of iridectomy in glaucoma is in direct ratio to the prominence of the so-called inflammatory phenomena; that the extension of the disorder is retarded, or some improvement produced by a partial regression of the effects of tension in cases where only excavation and increased tension constitute the symptoms; that iridectomy is futile where there is only excavation.

If now we try to find which nerves are diseased, we can only say that necessarily the fibres of the trigeminus are affected, and that an irritation of the fibres of the sympathetic is rendered very probable by the dilatation of the pupil; but we are not in a position to declare whether the increased tension depends upon the irritation of the trigeminus or of the sympathetic. We can certainly express the opinion that iridectomy acts not by the section of any particular nerve-fibres, for it is quite immaterial at what part of the corneal periphery the incision is made, or what particular section of the iris is removed. Whether the centre which controls the nervous phenomena lies in the peripheric part of the iris or in the sclerotic, is to this point undetermined. But it is certain that iridectomy remains ineffective when the incision lies in the cornea; and I have seen that the iridectomy controls acute glaucoma as well when a pretty wide zone of iris is left at the pupillary margin as when such a zone is left at the ciliary margin, provided only that the incision be commenced beyond the sclerotic margin. How constantly tension of the ciliary periphery of the iris brings on increase of tension we learn from the pathology of hydrophthalmus. It is very probable that we have to look for the seat of the starting-point of the morbid condition in the peripheral portion of the chamber. In a memoir, the original of which unfortunately is not at hand, but which I can

refer to in vol. iv. of "Klinischen Mon.-Bl. f. Augenheilkunde," Solomon has expressed the opinion that iridectomy exercises its curative influence by section of the nerves of the iris as they pass out from the ciliary muscles, and with this view he had recommended the so-called "intra-ocular myotomy" for cases of non-inflammatory glaucoma. By this operation only the indicated nerve-fibres will be divided without any injury to the iris. Clinical experience will show whether pure sclerotomy * will be as effective against the glaucomatous phenomena as is iridectomy. Anatomy and physiology must then show us the nerve-paths along which the disturbances travel.

With this agrees the view which v. Wecker and v. Stellwag take of the curative action of iridectomy, for they see in the scleral wound of incision, or rather the cicatrix of the same, the active element, and regard the excision of the iris as unessential. They believe that the fundamental lesion is cured not by the iridectomy, but ascribe to the cicatrix of the scleral wound certain properties which render the further progress of the disease innocuous. V. Wecker maintains that in consequence of the increased tension in a glaucomatous eye the cicatrix after iridectomy never attains the density of an ordinary cicatrix, and that, in consequence of its permeability to the fluids of the eye, filtration through the callous mass is favored. Since v. Wecker has assumed for the scleral cicatrix which follows a properly made iridectomy for glaucoma certain conditions which Coccius † formerly sought to establish by combining iridectomy with iridencleisis, he has found a way to explain the diminution of tension. V. Stellwag refers to Lubinsky, who demonstrated that scleral wounds do not heal by direct application of the edges, and believes that the cicatricial tissue, thus introduced into the inelastic capsule of the glaucomatous eyeball, is capable of covering the defect in the elasticity of the tunics.

We may remark that both of these explanations fail to cover the entire ground; they attempt only to make intelligible the diminution of tension. Increased tension is not all identical

* V. Wecker, Klin. Mon.-Bl. f. Augenhlkde., viii., p. 385, und ix., p. 305. Quaglino, ibid., x., p. 299. Secondi, ibid., x., p. 300. V. Stellwag, Der intraocul., Druck, etc., p. 47. Lehrbuch der pract. Augenhlkde, 3. Auflage, p. 356.

† Ueber Glaucom, Entzündung, etc., p. 18.

with glaucoma; and since the iridectomy not only corrects the tension, but also abolishes other morbid phenomena, as for instance the haziness of the cornea, and the pain which is independent of the tension, such theories lack in comprehensiveness.

V. Arlt, Becker, and v. Reuss have discussed the weighty objections to v. Wecker's theory which are furnished by clinical observation.* V. Stellwag's position is shaken by Schweigger's anatomical investigations.† It was already weak enough since Lubinsky, to whom Stellwag appeals, speaks only of scleral wounds penetrating to the corpus vitreum; and what he says concerning the healing process of such wounds cannot, without a good deal of straining, be applied to such wounds extending to the anterior chamber. I was once enabled to see that Lubinsky's statements apply also to the human eye. It happened in this wise: a patient had, several months previously, received a scleral wound which lay at about 3‴ distance from the inner corneal margin. The eye had become phthisical, and at this time there was no sign of inflammation. When I threw the light into the pupil I could see it at the point of the scleral wound, and between the widely separated margins of the former wound I could see a transparent mass. Even allowing that the scleral scar after iridectomy for glaucoma exhibits anatomical conditions similar to those possessed by scars from wounds which have penetrated the vitreous body, we need not assent absolutely to the properties claimed for the latter by v. Stellwag, since Lubinsky himself says that in one of the experimented cases the eyeball assumed a preternatural hardness even after the wound had perfectly healed, "and at the same time the hardness was relatively more perceptible towards the point of the previous lesion."‡

* Klin. Mon.-Bl. für Augenhlkde., vii.; v. Arlt., p. 386; Becker, p. 391; v. Reuss, p. 400.

† Lehrb. der Augenhlkde., 3 edit., p. 530.

‡ L. c., p. 382.

ON TATTOOING THE CORNEA, WITH REMARKS UPON THE ETIOLOGY OF GLAUCOMA.

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Translated by C. C. Terry, M. D.

SINCE 1869, when v. Wecker announced his now well-known procedure under the name of corneal tattooing, the literature of the subject has become very profuse, and from all directions have come in reports of successful cases. So the description of another case would not excite much interest, were it not for some circumstances which in my opinion are calculated to throw light upon certain pathological conditions.

The case about to be described is instructive also, in view of the large surface tinted, the employment of a pigment other than the ordinary India-ink, the great number of sittings necessary, and the extent of work done at each sitting.

The history of the case is briefly as follows:

May 25, 1874, I was consulted by a youth of eighteen years, from Salonichi, who had lost his right eye half a year previously in consequence of Egyptian ophthalmia. Examination discovered a considerable papillary swelling of the tarsal portion, and also a swollen condition of the transition folds of both upper lids; but the left globe was quite normal, as also the sight of that eye. On the right side the cornea was replaced by a bluish-white dense cicatrix, which did not project beyond the outline of the normal cornea. At its inner and upper portion the cicatrix was comparatively thin, and at one place, of about the size of a pin's head, it looked dark and permitted the fingers to be counted at 2′. No iris or chamber could be made out with certainty—the iris probably being entirely merged in the pseudo-cornea. There was evident perception of light in all directions, as also projection of light from the illuminated retinal regions. Tension normal, and healthy condition of the ocular conjunctiva. Slight strab. converg.

Till July 19 the conjunctiva was touched daily with sulph. of copper in substance, and the papillary swelling entirely reduced. During this treat-

ment the thin part of the cornea had repeatedly given way, as was evidenced by the escape of a clear fluid, and the sudden softening of the bulb, as also the flattening of the cicatrix and the appearance of slight pain in the superior ciliary region. But the application of a compress for a day or two always sufficed to restore the normal tension of the bulb.

I then proposed to the patient to blacken the cicatrix; and he readily accepted the offer. My intention was to make an imitation pupil of 2‴ diameter, and to color the remaining cicatricial periphery a deep brown like the iris of the other eye.

I began by making six punctures with a fine discission-needle in the centre of the scar and depositing some well-rubbed India-ink. The ink adhered nicely at every point, and, after ten sittings at intervals of two days, twenty-five punctures had been made, and there remained a round black pupil.

After each sitting a bandage was applied. I operated without a fixation forceps and lid-holder. The punctures were painless, and the patient's behavior was excellent.

On the 4th of August I began to imitate the iris with sepia and siena, and made a few punctures quite on the thin part of the scar, to test its reaction. Altogether there were thirty punctures; but they were not permanent.

August 5.—I noted, since last evening, severe pain in right side of head, extending from eye. Globe of bony hardness; cicatrix projecting, and conjunctival vessels distended. Marked peri-corneal injection. Vision diminished to mere perception of light. Compress laid aside, and anodyne salve prescribed.

August 13.—Reopened the former corneal fistula by means of a reclination needle. A drop of clear fluid escaped, and the globe immediately became quite soft.

Next day the tension was normal again, the scar resumed its former condition, and fingers could be counted.

August 16.—Pricked the parts with the Weiss-Taylor instrument. Next day tension again increased, making another puncture necessary.

August 22.—Tension again increased a little. A thin blister of epithelium over the tattooed point, and through it the underlying substance appeared gray and hazy.

August 27.—Tried the Weiss instrument, using terra di Siena mixed with India-ink. No result.

August 29.—Commenced again—this time with Stellwag's grooved needle and the last-mentioned pigment.

Till November 8th we had forty-one sittings, one every other day, and I

ventured to expedite matters by making 20–100 punctures at a sitting. During this time puncture was rendered necessary by increased tension on three different occasions, the last time after the tattooing was quite finished. The ultimate effect was such that at a distance of 2′ the color of the eye could not be distinguished from that of the other eye. The only trouble left was the slight divergent squint, which the patient declined to have operated. The pupil was not quite so black as normal, but still it made an agreeable contrast with the brown iris, which here and there showed a lighter tint. The tension of the globe was normal. Fingers not quite so distinct as before, but their outlines still distinguishable.

In summing up the experience which I acquired in this case, as regards method and coloring matter, the most emphatic point is that it makes but little difference what instrument is employed, if India-ink be the tincture used. Either a grooved needle, as used by v. Wecker, v. Hasner, or v. Stellwag, the Taylor-Weiss insrument, or, after Klein's example,* an ordinary fine discission needle. Taylor's method appears to me to be the least satisfactory. If some pigment not easily fixed is to be used, the grooved needle is best. And some care must be taken to let the tincture dry a little in the groove of the needle and to keep the point free. Let the needle enter the surface of the tissue almost parallel, then push it under the epithelium for a distance of 1–2 mm.; let it lie for a second or two, and withdraw it with a little pressure. The fluids of the tissue will dissolve the material, and, in withdrawing the needle, a little streak will be left. In this way, as Klein has remarked,† streaks instead of mere points will be made, and the proceeding considerably shortened.

For the brown tints I have used brown ochre, sepia, and terra di Siena; but none of them stick as well as could be wished. It is only by mixing the siena with a proportion of India-ink that we can get an adhesive tincture and a color so like the dark-brown pigment of the iris.

The number of sittings and the number of punctures made each time must depend a good deal upon the extent of surface to be treated and the quality of the pigment. When India-ink is used alone, it is agreed by all authors that 6–13 sittings will suffice,

* Dr. S. Klein, On Corneal Tattooing. Wiener med. Presse, 1873.
† L. c., p. 4.

according to the extent of surface to be treated. But if some less manageable pigment be used, the number of sittings required will be much greater. The mixture which I used left a yellowish-brown streak, which by the time of the next sitting (about forty-eight hours) had faded somewhat, and required several deposits at the same spot. So the same spot must be gone over three or four times to get the desired tint.

In regard to the number of punctures, I have already remarked that, in order to obtain a brown coloration, I sometimes pricked as many as 100 times at one sitting; but this was only after I had learned that the increase of tension, which occasionally appeared, was only after my attempts to tattoo upon the inner upper thin part of the scar, where also the pigment was most difficult to fix. v. Reuss makes 20–30,* v. Wecker 10–15,† and Klein‡ not above 10 punctures at a time; so the entire number of sittings will make up 100–200 punctures, and this, as I have already remarked, when only India-ink is used and the leucoma not extensive. In the present case I needed only 120 punctures for a beautiful pupil 2‴ in diameter. But to get the brown (and bearing in mind the much larger area), I was obliged to make more than 2,000 punctures.

In regard to retention of the pigment, I think, contrary to v. Wecker, that a pretty firm scar affords better ground than a softer one, and there is less chance of the pigment escaping from the puncture to be washed away by the tears and the movements of the lids.

But the most remarkable feature of my case, as it appears to me, was the *glaucomatous* condition of the eye, coming in first after the twelfth sitting, and the perfect restoration of the eye by artificial reopening of the corneal fistula. There was increased tension four times in the course of the attendance—once, indeed, in the midst of a sitting. I could each time recognize that the lenticular apparatus was thrust forward; there was distinct bulging of the middle part of the scars; the lens could be pushed

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* A. Ritter v. Reuss, On Corneal Tattooing. Wiener med. Presse, 1873.

† v. Wecker, On some New Ophthalmic Operations. Wiener med. Woch., 1871, and Arch. f. Augen- und Ohrenhlkde., ii., 2, p. 86.

‡ L. c., p. 3.

to and fro between the fingers pressed upon the inner part of the scar, and was evidently closely applied to its posterior surface.

V. Arlt, in his treatise on Operations,* remarks, from the experience of v. Reuss and v. Arlt, Jr., in tattooing upon a leucoma adhærens, that pretty sharp reaction occurs and forewarns the operator against appearance of the increased tension when there is a marked ectatic cicatrix.

In his second publication on this subject, v. Reuss † has made some theoretical reflections upon the increased tension and bulging of the cicatrix; but Klein ‡ relates the case of a girl of thirteen years, in which, after four punctures into a moderately firm cicatrix, there was so much bulging that he declined to proceed with the treatment.

My case offers a very striking example of these morbid conditions, and, by reason of the frequent reappearance of the morbid process, checked at once by surgical interference, plays the rôle of an experiment, and encourages me to say a word in the *discussion upon the etiology of glaucoma.*

Although Donders, v. Graefe, and a long list of later authors and experimenters look for the cause of the increased intra-ocular tension proper to acute primary and chronic glaucoma in an anomaly of secretion which sometimes figures as a reflex phenomenon, and though Stellwag, relying upon the observations of Cusco, Coccius, and others, find an explanation of the anomalous secretion and resulting increased tension in the rigidity of the capsule of the globe, still it must be admitted that the conflict of opinion has evolved no absolute result on either side, and that to-day neither experimental observation nor anatomical research, though especially applied to the sclera, has solved the problem.

But secondary glaucoma is quite another thing.

On this point Stellwag § says: "Moreover, it is an undisputed fact that injuries and inflammations, which are liable either directly or indirectly to cause and maintain an irritable condition of the ciliary system, may often bring on, even in an

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* Handb. der gesammten Augenhlkde., iii., 1, p. 384.
† 2 L. c. ‡ L. c.
§ Lehrb. der practischen Augenhlkde., 4th ed., 1870, p. 349, et seq.

eye not previously disposed to it, increased intra-ocular tension with excavation of the optic nerve—conditions especially which have much in common with true glaucoma, and which, with reference to their origin, are classed as secondary glaucomata."

He expressly ascribes this influence to "certain filaments of the sensitive ciliary nerves, which under morbid conditions are capable of affecting the intra-ocular tension," but explains the connection by the assumption that "either a paralysis of the vascular apparatus furnishes the conditions for a persistent venous congestion, or secondary changes in the sclerotic prepare the way for the glaucomatous process."

If we scrutinize a little more carefully the grounds upon which Stellwag bases his opinions regarding the secretory nature of glaucoma, both primary and secondary, and which have led him into far-fetched explanations, we find that they are mostly of a negative character: thus, the insufficient and often contrary results of experiments, the necessity of supporting the hypothesis of a special secretive anomaly by assuming an opposite condition of innervation between the anterior and posterior half of the globe, and finally the persistence of increased tension for months and years, which presupposes an equally persistent pathogenetic cause.

And if with Stellwag we doubt the significance of manometric and tonometric results in favor of the secretory origin of glaucoma, it does by no means follow that such opinion should presuppose a different condition of innervation between the anterior and posterior halves of the globe. For if Stellwag accounts for the diminution of the volume of aqueous, in case of increased intra-ocular pressure, for the most part by increased transfusion through the cornea, the adherents of the secretion theory may claim the same event in their mode of explanation, since they suppose that, without detriment to the increase of secretion in the vitreous, filtration through the cornea overbalances the increased secretion in the anterior chamber. And they can appropriate the fact urged by v. Graefe,* that increased tension in the child's eye affected with leucoma begins with a distention of the anterior chamber. But aside from this, and without men-

* Arch. f. Ophth., xv., 3, p. 132.

tioning that transudation through the cornea is still a debatable question, it is not quite satisfactory to explain the marked shallowness of the anterior chamber, which, in a case of acute glaucoma, happens in the space of a few hours, by a transfusion through the cornea, and which in some cases ought to be discoverable. And the sudden release of this fluid should be considered a kind of self-regulation of the morbid process, and the shallower the anterior chamber, the better should be the chances of a spontaneous recovery; while, in truth, common experience makes us regard this diminution of the anterior chamber as a bad sign.

It appears to me more plausible to explain the movements of the fluids in the eye by the physical laws of osmosis, according to which two fluids, separated by a thin organic membrane, seek to establish an equilibrium in the manner that the one subjected to greater pressure flows towards the other. The iris, lens, and ciliary body represent such a diaphragm, separating the aqueous from the vitreous; and it must be assumed that the tension is higher in the perfectly closed aqueous chamber than in the vitreous chamber with its many venous outlets. Then the aqueous will flow inwards, either to be taken up by the veins and lymph-ducts of the iris, or to increase the volume of the vitreous.

Stellwag himself remarks that the diminution of the aqueous may be effected partly by increased absorption, since increased pressure upon tissues promotes absorption. But by absorption nowadays, we understand that osmosis in organic tissues which is governed by the nerves.

The slimmest objection, it seems to me, is that the long persisting increased tension requires a persisting pathogenetic cause; for if the cause of the increased tension be once established, there is constructed the vicious circle, so masterly described by Stellwag himself, which can be broken only by a very favorable disposition of the extra-ocular vascular tension, or by artificial interference.

Allowing that in the production of a primary glaucoma, the rigidity of the capsule of the globe is a factor, but whose value is still undetermined, it appears to me that, as regards secondary glaucoma, everything indicates the importance of an alteration of the secretion in the production of increased intra-ocular tension;

and to this view I am the more strongly inclined by the circumstances of the present case. Indeed I may assert that I was able, though unintentionally, and quite contrary to my wishes, to produce glaucoma—an achievement which Haffmanns * considers unattainable in experiments upon the lower animals.

There happen cases of glaucoma where one may be in doubt whether to call the disease primary or secondary, and where it is most convenient to consider irritation of the sensitive ciliary nerves as the cause of the increased tension. Here I must refer to v. Graefe, who was perfectly convinced "that irritation of the cornea (*i. e.*, of its nerves) is sufficient in itself, without intermediation, to give rise to glaucomatous increase of intra-ocular tension." He cites the unprecedented case in which he had seen a periodical succession of circumscribed corneal infiltrations, followed each time by glaucoma. Lately I observed such a case, and I may very properly narrate it here.

In the latter part of July past there appeared at the Clinic a woman of fifty-four years, whose left eye exhibited a little redness and swelling of the lower part of the conj. bulbi, with slight swelling of the lower segment of the limbus conjunctivalis, and no other abnormal appearance. She said that the right eye, whose pupil was dilated and motionless, had become blind the year before, in the following manner: In the course of her attendance at a children's hospital, where her little boy was treated, she had several times suffered from inflammation in this eye, and had been relieved by the use of yellow precipitate ointment. One day she consulted the oculist of the institution, on account of a new attack. He told her that her eye was very seriously diseased, and advised her to go to an ophthalmic clinic at once. She did so; and the director of the clinic, after explaining to her that her anxiety and that of the physician who sent her were groundless, put a drop of a clear liquid, which caused no pain, into the eye, applied a compress, prescribed a powder, and directed her to call again in a few days. But that same night she was awakened by a fearful pain in the right side of the head, which increased next day to such a degree that she could not go out; and so, instead of returning to the clinic, she lay six weeks in bed, suffering intensely. By that time the pain was gone, and so was the sight of that eye. When I examined this eye, I found just below the middle of the cornea a circular opacity as large as a hemp-seed; the anterior chamber was of nor-

* Arch. f. Ophth., viii., 2, p. 161. † L. c., p. 121.

mal size, pupil moderately dilated and motionless; color of iris not noticeably changed; aqueous clear; tension much above normal; no perception of light. Ophthalmoscope showed clear media, and a deep glaucomatous excavation in the stage of atrophy.

Evidently there had been a circumscribed corneal infiltration preceding the glaucoma, which now had passed by. The condition of the blind eye made me more particular in the examination of the other. The pupil, of normal size, reacted promptly; anterior chamber rather deep than otherwise, and aqueous perfectly clear. Tension normal. S with $\frac{1}{60} = \frac{2}{20}$. Field of vision on nasal side hardly encroached upon (56° Förster, with a high nasal ridge). Ophthalmoscope showed perfectly clear media, and no trace of papillary excavation. But when questioned, the patient informed me that she had lately seen colored circles around the candle-flame. The possibility that the slight episcleritis present threatened glaucoma, was not to be overlooked. I therefore refrained from meddling with the eye, ordered abstinence from use, and avoidance of bright light, and told her to return soon. That week I saw her twice, and found no change. But on the 6th of August her daughter came with the information that she had been lying three days with terrible pain in the left eye and left side of the head. In the evening I called to see her. The trigeminus neuralgia proceeding from the eye was indeed frightful, and the attempt to examine her sitting up in bed brought on a fainting-fit. (She was a very stout woman, and always suffered from palpitation of the heart, but had no valvular lesion). The lids and connective tissue were œdematous, cornea slightly clouded around the margin, aqueous slightly hazy, chamber of normal depth, iris slightly darker in color, pupil moderately dilated, irresponsive, and the vitreous in its anterior portion flecked with thin opacities. Tension increased ad maximum, and upper ciliary region extremely sensitive. In the dim light, fingers counted at 3′; visual field restricted on nasal side.

The happy effects of a subcutaneous injection of morphia reconciled the patient with the idea to be operated on, the next day. I made the iridectomy from above with the best result. In 10 days S = $\frac{20}{40}$.

Considering all the circumstances developed by the history of the right eye, we can hardly avoid the conclusion that here was a succession of corneal infiltrations, with consequent glaucoma; and with this view is consistent the fact, that at the very beginning an evidently inflammatory glaucoma developed into the form of a glaucoma simplex, with apparent dependency upon the inflammatory corneal disease, the subsidence of which caused the

inflammatory symptoms of the glaucoma to disappear. That the former attacks found a good ground for the development of glaucoma in the right eye, is rendered pretty certain by the peculiar course of events in the left, where the usual order of things was widely departed from.

Looking at the first described case with an eye to the different theories upon the origin of glaucoma, I must strongly insist upon the absence of rigidity of the capsule of the globe in this patient, a perfectly healthy young man of eighteen years, since, as already remarked, on the day when the corneal fistula was opened, the globe became peculiarly soft and yielding. That the posterior parts of the eye, especially the retina, were not implicated in the destructive process which had taken place in the anterior portions, was plain from the fact that even the thick cicatricial tissue did not extinguish the perception of light, and through the thin part of the scar he could count fingers at 2′.

During the first eleven sittings, with 129 punctures, the eye was perfectly tolerant; the tension was in no wise disturbed, and there was not even pain. It was only after the twelfth sitting, when I made several punctures in the thin part of the scar, where the corneal tissue was still pretty normal, and tried to insert the sepia, that the courageous patient began to complain of pain, and in four hours the glaucoma set in.

The suddenness of the invasion and the speedy extinction of sight, the enlargement of the globe, as indicated by the bulging of the cicatrix, can, it seems to me, be satisfactorily explained only by a sudden excess of secretion in the vitreous. Whether this was the primary condition, or only secondary to the admitted intra-ocular venous congestion, or the reverse order of events, cannot be definitively settled; but I am inclined to the first view, because there is no clear pathological relation between venous congestion and irritation of the sensitive ciliary nerves, and there are many analogies which render probable the relation between irritation of the sensitive nerves and increased secretion.

It is also noticeable that the thin tissue closing the corneal fistula, which only a few days before the attack had repeatedly given way to the vis-a-tergo of the retained fluid, remained unbroken during the glaucomatous attack. This observation seems to me peculiarly significant, in view of the idea which we form of

the effect of intra-ocular pressure in cases of ulcerative perforation of the cornea, and it also throws a strong light upon the origin of such perforation under external pressure.

No less remarkable is the perfect restitutio ad integrum after artificial reopening of the corneal fistula and escape of so small a quantity of fluid, as also the mode of retrogression. Perforation of the cornea in acute glaucoma is generally followed at once by advancement of the iris and lentricular system; but in my case the escape of a drop of fluid was followed by recession of the lens and the scar, an argument that it was not so much aqueous as a retro-iridal fluid that made the trouble, and that in case of increased intra-ocular tension the vitreous volume is but the least increased.

The curative effect of artificial interference after each relapse, and especially the recovery and persistence of normal tension* after the last sitting, proves to me that in this eye there were none of the conditions predisposing to glaucoma, but that the effect observed were due entirely to the multitude of little wounds.

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* A few weeks ago I was told by a neighbor of my patient that he was quite satisfied with his eye, and that its condition was unchanged.

HISTORICAL NOTICE ON SYMPATHETIC OPHTHALMIA.

By J. HIRSCHBERG, of Berlin.

Translated by Edw. H. Fridenberg, of New York.

Mackenzie, Beer's great pupil, undoubtedly deserves great merit for his investigations on sympathetic ophthalmia, and it is not my intention to detract from this merit. But I think it ought not be forgotten that, as early as 1835, v. Ammon, whose name is not even mentioned in the historical introduction to Mooren's excellent monograph, wrote the following in his prize essay on iritis:

"Iritis traumatica in altero oculo vulnerato orta haud raro ad alterum oculum sanum transmigrat. *Pluries morbosam hanc oculorum sympathiam observari.* In primo casu senex dextro oculo vulnus perpessus fuerat scleroticæ late patens; iridis inde tantus prolapsus et tanta ejus dilaceratio, ut dimidia ejus pars plane evanuerit. Vix credideris, ingentem hanc bulbi vulnerationem nullam fere subsecutam esse iritidem. Duos autem post menses uveitis sese ostendit altero in oculo; post curam tum bulbi morbo, tum dyscrasiæ humorum arthriticæ, qua senex laborabat, oppositam, oculi acies hujus senis ita conservata est ut rura sua colere pergeret. Altero in casu virgo bulbi dextri concussionem machinulæ improvisa explosione perpessa fuerat, quæ nostris diebus incendio inservit pulveris sulphurei artificialis subitaneo. Cæcitas ex hæmophthalmia subsequebatur insanabilis. Quatuor fere post menses uveitis orta est in altero oculo tum late et celeriter serpens, ut maximum inde minaretur huic bulbo periculum. Nullius dyscrasiæ in hac virgine adfuit vestigium. Elucet inde *intima utriusque bulbi et in statu morboso sympathia*, et necessarium medici ocularii officium, ut in iritidis traumaticæ quæ unum bulbum occupat, cura, in alterius bulbi iridem maximam convertat animi attentionem, *ne hæc inflammatione sympathica afficiatur, quæ visui periculosissima esse solet.*"

When one eye is wounded, and traumatic iritis ensues, the

disease not unfrequently attacks the other sound eye. I have noticed this morbid sympathy in more than one case. The first was an old man, who had received a wound in the right eye. The sclerotic gaped widely, and the iris was so much lacerated and had prolapsed so far, that the half of it was visible. It is highly astonishing that such extensive injuries to the eye were not followed by iritis. Two months later, however, an inflammation of the uvea appeared in the other eye. The requisite measures having been taken for the disease of the globe of the eye and the arthritic dyscrasia of its humors, with which the old man was also affected, he recovered his eyesight fully, and was thus enabled to follow his calling, which was that of a farmer.

The second case was that of a young girl, who had received a blow on the eye by the sudden explosion of a percussion-cap. The ensuing extravasation of blood made her incurably blind. Four months later the other eye was attacked by uveitis, which spread so rapidly that the danger of losing this eye was imminent. There was no dyscrasia in this patient.

The intimate sympathy of both eyes when disease is thus fully proved, making it the duty of the oculist, in cases of traumatic iritis of one eye, to pay the closest attention to the iris of the other, in order to detect at the outset sympathetic inflammation, by which the eye is liable to be lost.

ON THE ANATOMICAL CAUSES AND THE NATURE OF SYMPATHETIC OPHTHALMIA.

By Dr. ADOLF ALT, of New York.

THE subject of sympathetic ophthalmia has received the greatest attention, but mainly from a clinical standpoint, whereas its anatomical peculiarities have been singularly neglected. It was through the liberality of some of my colleagues that 32 eyes were placed at my disposal, which had been enucleated on account of sympathetic affection of the fellow eyes. In addition to these cases, examined by myself, I have compiled 78 others, selecting the most detailed ones, from the literature which was at my disposal. Thus I am enabled to present statistics of 110 eyes, all of which were enucleated on account of the stated affection. They are collected in the tabular statement at the end of this paper.

The eyes, furnished by Dr. Mooren, were given me by Dr. H. Knapp; the others I owe to the kindness of Drs. H. Knapp, E. Gruening, and T. R. Pooley, of New York, and to Drs. E. Williams and Ayres, of Cincinnati. To all these gentlemen I express my warmest thanks.

ANATOMICAL DESCRIPTION.

I.

Globes Enucleated on Account of Sympathetic Irritation.

1.

The following globe was enucleated by Dr. H. Knapp. The *Clinical Journal* presents the following notes:

Patient, Fr. Br., æt. 22. Six weeks previous to admission left eye was injured by a steel splinter. Since that time he has suffered intense pain in the injured organ, in which the right now participates. Furthermore, the right eye presents photophobia and excessive lachrymation. The left eye, at the lower ciliary region, has a scleral cicatrix and severe

ciliary neuralgia, chemosis, and iritis. The pupil shows a yellow reflex; on the floor of the anterior chamber is found a spongy, lens-like exudation. The enucleation was made upon the day of admission, followed by a rapid cessation of all the symptoms in the right eye.

The globe is of normal size. The section shows that the sclerotic, at the site of the lesion, is thickened, and that the choroid, retina, and a large ciliary nerve, are involved in the cicatrix. From the cicatrix a new-formed tissue passes into the vitreous chamber, which is filled by exudations. A neoplasm projects from the entrance of the optic nerve into the exudation in the vitreous space. The retina and choroid are attached to the sclerotic. The lens is normal.

A microscopic examination of the corneal tissue shows it to be completely normal; its marginal vessels are very hyperæmic.

The lens-shaped spongy exudation, in the anterior chamber, consists of a closely reticulated network of extremely fine fibrillæ of fibrin. Its interspaces contain some serous fluid, with an occasional round cell.

The iris is thickened and filled with numerous round cells and a quantity of hemorrhagic spots. Its vessels are very tortuous and hyperæmic. Its uveal pigment is very much diffused, especially at the periphery. The "angle of the iris" is choked with round cells.

The ciliary body contains fewer round cells than the iris, but is saturated with a serous exudation. The ciliary muscle presents no alteration.

The only place where the choroid is filled with round cells is at the site of the cicatrix; but all of its vessels are hyperæmic.

The Zone of Zinn has a thick coating of round cells, and the lens is entirely normal.

The pigmented scar is covered by a conjunctival tissue. The scleral margins of the wound are loosened, and abound with pigmented and round cells; its fibres seem to participate actively in the process of cicatrization, inasmuch as they pass into the cicatrix without sharp demarcation. The contents of the wound consist of a strip of connective tissue, which traverses the sclerotic, choroid, and retina, and is lost in the vitreous chamber. It consists of spindle-shaped and round cells, and contains much pigment

and new vessels. The divided tissues are inserted into this strip, as follows:

At a short distance from the cicatrix, the retina is found to be thickened, infiltrated with round cells; then its normal structure is entirely lost, being converted into a mass of spindle-shaped cells. Thus reduced, it coalesces with the cicatrix. The uveal pigment of the ciliary body sends long processes among the spindle-shaped cells into that part of the retina which has been thus transformed; and the uveal tract participates in the same changes. Its pigment is scattered in the cicatrix. The ciliary nerve, before it reaches the cicatrix, presents no visible pathological alteration, while in the scar itself it cannot be followed. All the tissues which participate in the cicatrization (except the nerve) are saturated with the remnants of former hemorrhages.

The other ciliary nerves show no pathological change.

The periphery of the retina is loaded with round cells, which condition is perceivable, almost without interruption, unto the site of the optic nerve. Some of the vessels of the retina are dilated, while others are reduced in calibre; the walls of all of them, however, are remarkably thickened.

An extensive piece of tissue, composed of round and spindle-shaped cells (granuloma), proceeds from the entrance of the optic nerve into the vitreous body. It not only caps the papilla, but proceeds from it. The connective tissue of the optic nerve, as well as its vessels, pass into this granuloma, which will be described later on.

In all probability this granuloma is attributable to a direct traumatism of the optic nerve. No foreign body could however be found in the globe.

The optic nerve is atrophied; the lamina cribosa and the longitudinal trabeculæ of connective tissue are materially thickened. Its vessels are hyperæmic. A number of hemorrhagic spots and coagulas of fibrin are found in the exudation which fills the vitreous chamber.

Anatomical Diagnosis.—Vulnus scleræ, involving the choroid and retina in its cicatrix; iridichoroiditis and traumatic retinitis; granuloma optici.

2.

The following globe was enucleated by Dr. H. Knapp, because of sympathetic irritation of the right eye. The history of the case presents the following points of interest:

A. B., æt. 30, presented himself for the first time in February, 1876, complaining of pain in his blind left eye and also in the right, which was healthy. In the left eye there was a soft cataract, the cause of which could not be stated by the patient. The iris was somewhat discolored and tremulous. The corneal epithelium presented irregularities. T. 1. —A bluish-black elevation, somewhat larger than the head of a pin, was found upon the lower part of the sclerotic, at 3''' from the corneo-scleral margin, which caused a doubt as to whether it was produced by a staphyloma of the sclerotic *sui generis*, or by an intra-ocular tumor. An enucleation was proposed; but the patient refused to consent to it. On June 5th he returned, and sought relief for increasing intense pain in the left eye, participated in by the right, and consented to have a small piece of the bluish-black substance removed, for the purpose of arriving at a precise diagnosis. This exploration revealed the fact that the case was one of a beginning scleral-staphyloma. The wound closed without reaction. The puncture afforded much relief to the patient, who left the institution two days later; but in two days more he returned, with a severe inflammation of the left eye—intense pain, photophobia, and lachrymation in both, and requested an enucleation. The day following the operation, all symptoms in the right eye had disappeared.

The globe is of normal size. The site of the puncture is depressed and covered with conjunctiva. Upon section the nucleus of the lens fell out of the capsule, in which some soft matter remained. Ciliary body much attenuated. A considerable extravasation is between the sclerotic and choroid at the site of puncture, and the posterior part of the ciliary body is involved in the cicatrix. Diametrically opposite to this spot, there is a second small staphyloma, exactly at the entrance of one of the venæ verticosæ. The nerve is deeply cupped.

The cornea is normal in all its parts. Its margin and the neighboring conjunctiva are very hyperæmic.

The cicatrix of the puncture shows the following microscopic details: Some vitreus, filled with round cells and pigment, is found between the scleral margins of the lesion. The wound

itself is covered by conjunctiva, which is infiltrated with blood and pus. The scleral margins of the wound, which must have been much thinned previous to the puncture, have regained their normal thickness, owing to an immense immigration of round cells. Furthermore, fresh red blood corpuscles are found among its fibres. Anteriorly, that part of the ciliary body which had been wounded by the puncture is involved in the cicatrix. That part of the ciliary body, which lies posterior to the wound and the adjacent part of the choroid, are separated from the sclerotic by extravasated blood, and crowded inwards. The tissues around the wound are suffused by a large number of round cells, and also are hemorrhagically infarcted. These conditions are maintained anteriorly as far as the periphery of the iris. The other parts of the uveal tract are very hyperæmic; otherwise normal. The ciliary nerves are very thin; their fibres, however, manifest no histological change. The layer of nerve fibres of the retina, as well as the ganglionic layer, are almost completely atrophied. The connective tissue elements are considerably thickened. The different layers of the retina show the remains of some old and a number of new hemorrhages of various quantities. The optic nerve is crowded beyond the boundaries of the sclerotic. The lamina cribrosa, which appears thickened, extends beyond the outer surface of the sclerotic. The vessels of the optic nerve are distended with blood, and its perineurium internum is thickened at the expense of the nervous elements.

Anatomical Diagnosis.—Cataracta mollis; glaucoma; staphyloma; vulnus scleræ; panophthalmitis circumscripta; atrophia nervi optici.

3.

The following eye was enucleated by Dr. Pooley, because of sympathetic irritation, which manifested itself in intense photophobia, lachrymation, and pain:

P. B., æt. 45, presented himself, some eight days previous, to the enucleation, stating that a splinter of iron had been forced into his right eye three weeks previously. At the time he had lachrymation, intense photophobia, iritis, and cyclitis dolens. Field of vision incomplete in an upward and outward direction. A foreign body, being supposed to be in the globe, enucleation was proposed, to which he did not consent.

He returned, in a week, with most severe pain and an aggravation of the above symptoms in the other eye. It now was evident that in the meanwhile the right eye had lost all perception of light. The anterior chamber was half filled with pus. The patient consented to the enucleation, which was performed without further delay. After it, all disturbances in the left eye disappeared rapidly.

The globe is of normal shape. A little more than half of the anterior chamber is filled by a yellow gelatinous mass. A similar product lies upon the macula lutea. No cicatrix appears either upon cornea or sclerotic, nor can any foreign body be found within the globe. The vitreus is perfectly clear, and macroscopically presents nothing abnormal.

Microscopically, the cornea appears unchanged. The endothelium of Descemet's membrane is crowded into the anterior chamber at several spots. The conjunctiva around the cornea is very hyperæmic, papillated, and saturated with round cells. The yellowish mass in the anterior chamber consists of threads of fibrin, closely reticulated, and enclosing some round cells. They are attached to the epithelium of the anterior surface of the iris, and can be followed into its substance. The iris is very hyperæmic, somewhat thickened, and replete with round cells. Its uveal pigment is somewhat loosened. The innermost layers of the ciliary body also show a number of round cells. Its vessels are hyperæmic. In several places there are found considerable extravasations, which crowded the fibres of the ciliary body apart. The ciliary nerves are normal. That part of the choroid which is adjacent to the ciliary body has within its inner layers a number of round cells. Further back, the choroid is very hyperæmic, and its vessels around the optic disc are much ectatic. Retina histologically unchanged. The exudation lying upon the macula, like that in the anterior chamber, consists of fibrin and round cells. In the vicinity of the macula, the threads of fibrin are firmly interwoven with the nerve fibres. The lens is perfectly normal. A microscopic search for a cicatrix or foreign body proves unavailing, showing conclusively that this is a case of contusion of the globe.

Anatomical Diagnosis.—Contusio bulbi; iritis purulenta; cyclitis, with hemorrhages; plastic choroiditis.

4.

The following eye was enucleated by Dr. E. Gruening:

Cl. G., æt. 67, had presented herself at the Clinic, two months previously, with severe neuralgia in her blind right eye, extending to her head and the left eye. She asserted that vision in her right eye had been lost fifty years ago, by a cold. The lens was cataractous, chalky, and dislocated downwards, lying upon the ciliary body. This could be easily perceived, since the lower part of the iris was shrunken to a thin unpigmented strip. Palpation revealed some hard spots upon the sclerotic, in all probability ossifications. The enucleation freed the left eye from irritation.

The ball is of a little more than medium size. A thickening of the insertion of the iris, at its scleral margin, somewhat reduces the depth of the anterior chamber. The iris is very thin. The anterior chamber is filled by a gelatinous exudation. The lens is calcified, and rests upon the ciliary body, behind the iris. The ciliary body is atrophied. A thin membrane, proceeding from the posterior part of the ciliary body, extends behind the lens. The space between it and the iris is filled by a gelatinous exudation. The ciliary body and the choroid are firmly attached to the sclerotic, which appears normal. The choroid is more or less thickened, and contains a number of bony formations. The retina cannot be recognized with the naked eye. The optic nerve is atrophied.

Microscopic examination yields the following:

The cornea is normal; at one part of its periphery the epithelium is somewhat thickened, but the tissues beneath are normal, thus excluding a perforation. Schlemm's canal is completely obliterated. The insertion of the iris is attached to the posterior surface of the cornea and stretched upon it, so as to represent a mere strip of atrophic membrane. Thence it curls inwards, regains its normal thickness, and is infiltrated with round cells. At this part of the iris the pigment of its stroma has been entirely destroyed, while that of the ciliary body and choroid has been partly destroyed. Near the papillary margin the iris is converted ino a thin tough strip of connective tissue, which has but few vessels and no pigment. Parts of the sphincter are preserved. The anterior surface of the iris is entirely covered

by a vitreous membrane, which, by low magnifying power, appears structureless; but higher powers show in it globular hyaline bodies, arranged like tiling, as are the cells of the epithelium upon the anterior surface of the normal iris. They seem to me a colloid metamorphosis of that epithelium. At other places, even under high power, there is a somewhat granulated hyaline continuous membrane discernible, probably resulting from a confluence of these colloid bodies. I cannot state what relationship this membrane may bear to those described by Donders and H. Müller as vitreous membranous new formations. The structures they described had no cellular elements, but were purely hyaline. The whole ciliary body is greatly atrophied, most so at the place where it was pressed upon by the dislocated lens. The vessels of the iris are scant, and their muscles are reduced to a few thin fibres, enclosing a partly serous, partly sero-purulent fluid. The fibres of the choroid, in the vicinity of the ciliary body, are crowded apart by the same kind of fluid. The stroma of the choroid is converted into coarse connective tissue, in which only the peculiar arrangement of blood-vessels and pigment recalls its former structure. The apparent thickening of the choroid, when seen with the naked eye, results from the addition of connective tissue, little bony plates, and remnants of the retina. The choroid itself is atrophic. The ossification is but incipient and peculiarly interesting in regard to its origin. The osseous plates never lie within the choroidal tissue, but *upon* it. The lamina vitrea is visible in all these sections which I made through the ossified parts, and is always situated *beneath* the bone. Furthermore, the peripheral parts contain numerous colloid excrescences, which are infiltrated with phosphate of lime. More posteriorly they assume that characteristic greenish-yellow tint, which is communicated to osseous tissue by Müller's fluid; but they still retain their form. Others, however, contain bone corpuscles. At the periphery of the choroid there are larger plates with bone corpuscles, Haversian canals, and blood-vessels. This coincides with the conditions formerly described by Arnold Pagenstecher, and myself. Besides this, the neighboring retinal tissue contains osseous granules, which are surrounded with pigment, and have to be regarded as colloid excrescences of the choroid, metamorphosed, as I have previously described. (See

Contributions to the Path. Anat. of the Eye.) At other parts the retinal tissue has degenerated into connective tissue, with occasional extensive pigmentation. The pigmented epithelium is absent in some places, but considerably augmented in others. The membrane extending from the back of the lens through the globe is to be considered as a cyclitic product, and is formed mainly by the retinal layer of the ciliary body and the fibres of the Zone of Zinn.

A small part of the lens has undergone fatty metamorphosis, presenting no cellular formations, while its larger part consists of amorphous chalk, firmly attached to the capsule. The centre of the lens is occupied by a small nucleus of sclerosed lens fibres.

Notwithstanding these extensive changes in the globe, the ciliary nerves present no histological alteration; which fact is so much the more interesting and worthy of notice, as the total supra-choroidal space was found obliterated. The optic nerve, as far as removed, is converted into connective tissue, the contraction of which reduced the scleral foramen to a minimum.

The exudation which fills the cavities of the globe is of a sero-purulent nature.

Anatomical Diagnosis.—Irido-choroiditis plastica chronica, with complete atrophy of the iris, partial atrophy of the ciliary body and ossification of colloid excrescences of the choroid; detachment of the retina; atrophy of retina and optic nerve; cataracta calcarea.

5.

The following eye was enucleated by Dr. Pooley, it having been injured by a piece of steel four weeks previously. There was sympathetic irritation of the other eye, manifesting itself by pain and photophobia at the time of enucleation.

Globe of normal size. A cicatrix passes from the corneo-scleral juncture, meridionally backwards through the ciliary region. A section reveals the ciliary body to be attached to the cicatrix. The retina is detached, and all the cavities in the eye are filled by a hemorrhagic exudation.

The cornea presents no microscopic abnormities, except in the

region of the cicatrix. The iris is thickened. Its tissue is filled by round cells; many of its pigment cells are destroyed, and its vessels are hyperæmic. In the pupillary space, at the posterior surface of the iris and upon the ciliary body a fibrinous substance, saturated with blood, is found, uniting the normal lens to the iris.

The ciliary body is hyperæmic and infiltrated with pus, which presses its fibres apart. The retinal part of the ciliary body proliferates inwards, and draws the uveal pigment with it. Thence a fine fibrous network, enclosing fresh blood, passes diagonally through the globe and behind the lens. Posteriorly the network sends fibres to the inner surface of the retina, which is detached.

The retina shows no pathological modifications. The choroid is darkly pigmented, its vessels well filled, and its fibres separated by a small quantity of serous exudation.

The conditions of the cicatrix are as follows: The cornea and sclerotic, at the site of the lesion, are thickened. Their lamellæ enclose round cells and pigment. The cicatrix is covered by conjunctival epithelium, which penetrates rather deeply into the wound. The wound contains the periphery of the iris and the ciliary body. Both have lost their normal structure, and appear as a tissue, consisting of round cells and much free pigment, while their most external layers present a few spindle-shaped cells. The vessels of the prolapse are very hyperæmic. The ciliary muscular fibres have completely degenerated here. The tissues surrounding the lesion are filled with round cells.

The ciliary nerves are normal. The exudation occupying the anterior chamber is serous and filled with round cells.

Anatomical Diagnosis.—Vulnus corneo-sclerae, the cicatrix of which involves the iris and ciliary body; iritis purulenta; cyclitis plastica et serosa; choroiditis serosa.

6.

The following globe was enucleated by Dr. Knapp, because of suspected glioma retinæ. The notes of this case state briefly that the patient, a child, had suffered with some febrile disease, complicated with an affection of the eye, for a long time. It was brought to Knapp's Clinic, in Heidelberg, on the 24th of September, 1867; the diseased eye was found to be completely blind, staphylomatous in its anterior portions, while a yellowish

mass projected into the anterior chamber. A perforation of the cornea and sclerotic seemed imminent at several places. The other eye manifested a deep circum-corneal injection and intense photophobia.

The section of the globe, subsequent to enucleation, demonstrated that the affection was a chronic suppurative cyclitis.

Though the globe is abnormally small, still the cornea is considerably enlarged. The anterior chamber is filled by a somewhat pigmented tissue, extending beyond the ciliary body into the hyaloid space, which also is filled with an exudation. The lens is wanting. The retina is detached from the optic disc and crowded forward.

The microscopic conditions are as follows: At several places the cornea is converted into cicatricial tissue. It is infiltrated with round cells, so much so in its posterior lamellæ as to leave the corneal tissue barely recognizable. The neighboring conjunctiva and sclerotic are also filled with round cells. The tissue, which completely fills the anterior chamber and extends into the hyaloid space, has destroyed the endothelium of Descemet's membrane and the iris, and consists of a partly hyaline and partly fibrillary matrix, which contains numerous round cells, remnants of the pigment of the iris, and many vessels, some of which are very large.

The ciliary body is also permeated by round cells, especially its innermost layers. Its muscular part is normal and its vessels hyperæmic. Its retinal portion has been substituted by the above-described tissue. The ciliary nerves evince no pathological modification.

The pigment cells of the choroid are very pale (as is usual in children). The chorio-capillary layer is replete with round cells; veins hyperæmic.

The exudation, which lies between the choroid and retina and fills the rest of the hyaloid space, consists to a great extent of round cells, many of which contain two or three nuclei. The rods and cones of the retina are converted into club-like structures, and the granular layers are blended. The ganglionic and nervous layers are completely atrophied, and their connective tissue is much thickened. Those peripheral parts of the retina which are yet attached to the choroid are pigmented, and the free pigment lies in all the layers of the retina in the form of large

patches. The optic nerve is atrophied and its connective tissue much thickened.

Anatomical Diagn.—Keratitis, and irido-choroiditis and hyalitis purulenta, detachment and atrophy of the retina; atrophy of the optic nerve.

7.

The following eye is from Dr. Knapp's collection.

The history of this case says: The patient, Chr. Sch., presented himself on the 2d of April, 1868, stating that a splinter of iron had been thrown into his right eye two weeks before. The following night he suffered severe pain, followed by fever, deliria, and a rapid diminution of sight.

Stat. præs. (2. IV. 68.)—Some tumefaction of the lids, slight chemosis, deep injection of the sclerotic. The upper and inner half of the ciliary region is very tender to pressure. Slight projection of the sclerotic; a little inward from the vertical meridian the cornea shows a diffuse opacity. The upper and inner quadrant of the cornea slightly bulging and infiltrated with yellowish-white pus. The anterior chamber is filled by a yellowish-white mass of rather definite boundaries. Iris dimly perceptible at the upper and outer part. The presence of a foreign body cannot be determined. Paracentesis cornea. The patient was treated at the Clinic until April 25th, and, when dismissed, still suffered pain in the right eye, and especially at night. Deep circum-corneal injection; cornea depressed; iris discolored. Occlusion of pupil.—T.

The patient returned on the 20th of May, 1868, with the right globe atrophied and violent sympathetic irritation of the left. The right globe was enucleated on the same day.

The flattening of the cornea, and a consequent diminution of the anterior chamber, have produced a commensurate reduction of the size of the globe. The cornea presents a small central and a large marginal cicatrix. Section shows the iris closely adherent to the cornea. Behind it there is a broad cyclitic membrane. The hyaloid fossa is filled with a gelatinous exudation, and a similar substance is situated between the retina and choroid. The posterior part of the sclerotic is thickened, and materially contracted about the optic nerve. The entrance of the optic nerve is much thickened.

The microscope reveals the following conditions: The central

scar on the cornea is somewhat elevated; its epithelium, however, is hardly thickened. The elevation is caused by layers of tissue, parallel to the lamellæ of the cornea, which are wedged into the latter. Spindle-shaped cells of the cicatricial tissue proceed from the apex of the wedge through the cornea. Bowman's layer is curved inwards. The marginal scar shows thickened epithelium, which sends processes into the deep curves of Bowman's layer. Below and occasionally above this layer a very vascular tissue, containing numerous round cells (pannus-tissue), is found. The cornea is converted into scleroid tissue, sparsely provided with cells, but containing many vessels. As the convexity of the cornea is reduced, Descemet's membrane is wavy and its endothelium converted into spindle-shaped cells at such parts where it touches the iris. At several places these membranes are separated by a serous exudation.

In the ciliary region a cicatrix penetrates through the sclerotic and conjunctiva, and terminates in the ciliary body. It consists of spindle-shaped, round, and pigmented cells.

The tissue of the iris is irregularly thickened and filled with round cells; its vessels are hyperæmic. The pupil is occluded by a new-formed membrane. The ciliary body is adherent to the iris and drawn forward, so that the inner half of its muscle lies before its insertion. The muscular bundles thus drawn asunder, leave spaces between one another, filled with a sero-purulent exudation. Behind the above-described cicatrix, the ciliary body is drawn inwards by a large cyclitic membrane, which passes transversely through the globe. It consists, to a great extent, of an extensive proliferation of the retinal portion of the ciliary body, is scant in blood-vessels and envelops the Zonula Zinii, capsule, and remnants of the lens. It contains a number of round cells, especially in the neighborhood of the capsule of the lens.

The lens has assumed the shape of a saddle-bag, the isthmus of which is formed by a juncture of the anterior and posterior capsule. The lens fibres are destroyed, and substituted by liquor Morgagni and large vacuolated cells. The folds of the anterior capsule contain a tissue composed of round and spindle-shaped cells, permeated by fine vessels. The layers of the choroid are separated by a sero-purulent exudation. Some of its vessels are

hyperæmic, and the capillaries are surrounded by round cells. The majority of the ciliary nerves are normal. Only one of them is compressed in two places by the exudation, and even these two places present no other pathological modification.

The entrance of the optic nerve is infiltrated by serum, which separates its elements. Its vessels are distended with blood. The lymph-sheaths of the vessels are much dilated, and contain serum and lymph-cells. Hemorrhagic spots are found between the nerve fibres. The whole retina is œdematous. Many of the ganglion cells are converted into translucent vesicles, the result either of a colloid metamorphosis, or serous imbibition. The rods and cones are converted into granulated club-like corpuscles.

Anatomical Diagnosis.—Phthisis anterior; vulnus corneæ; vulnus scleræ; sero-purulent and plastic cyclitis; sero-purulent choroiditis; œdema of the optic nerve and of the detached retina, traumatic cataract.

8.

The following eye was enucleated by Dr. Mooren, and bore the clinical diagnosis: Phthisis bulbi traumatica; cyclitis; sympathetic irritation of the other eye.

The globe is somewhat smaller than normal, from flattening of the cornea. The iris adheres to the posterior surface of the thickened cornea by means of cicatricial tissue. The sclerotic is thickened around the entrance of the optic nerve. Macroscopical examination reveals no other pathological alteration.

The microscopic examination shows the following: The corneal epithelium, though everywhere else normal in structure, conically penetrates the underlying tissue in two places, near the corneo-scleral margin; at this part Bowman's layer is severed, and the lips of its wound are wavy. The parenchyma of the cornea, which is remarkably thickened, is converted to a great extent into an irregularly laminated connective tissue. At the site of the scar, two strings of cicatricial tissue permeate its entire thickness; they are vascularized, and contain a great deal of pigment. Descemet's membrane is corrugated and drawn into these cicatricial strings. Some tough connective tissue lies behind them, the

fibres of which are so regularly arranged as to resemble corneal tissue. To this tissue are attached fragments of the torn iris on one side and the whole iris on the other. The pupil is occluded by a membrane, which consists of spindle-shaped and round cells, and which is closely adherent to the before-mentioned membrane, and furthermore envelops the folded capsule and remnants of the lens. The tissue of the iris presents no other pathological change.

At the uninjured part of the iris the capsule of the lens is still connected with the ciliary body, by the Zonula Zinnii. On the other side the tissues surrounding the capsule are converted into a cyclitic membrane of the usual structure.

The remnants of the lens are partly granulated, partly decayed.

Rows of pigment pass from the ciliary body into the cyclitic membrane. A close investigation shows these masses to be entirely independent of the blood-vessels, though in their appearance they resemble them very much. They are simply proliferations of the pigmentary epithelium (cf. Schiess-Gemuseus).

The ciliary body is drawn forwards and inwards. Its tissue presents no modification. The retinal part of the ciliary body participates in the formation of the cyclitic membrane as usual. Also the peripheral parts of the retina participate in this formation, have lost all their cellular elements, and degenerated into connective tissue.

The ciliary nerves, the parenchyma of the choroid, and the pigmented epithelium are normal. The veins of the choroid are hyperæmic. The entrance of the optic nerve is somewhat thickened and traversed by many new vessels. Its connective tissue is increased and its nerve-fibres are atrophied. At some distance behind the lamina cribrosa the nerve-fibres are normal. The connective tissue of the retina is also thickened. Many of the ganglionic cells have undergone colloid degeneration, and the inner as well as the inter-granular layer contains spaces filled with colloid matter.

Anatomical Diagnosis.—Phthisis anterior e vulnere corneo-sclerale; synechia anterior totalis; irido-cyclitis plastica; hyperæmia choroideæ; detachment and atrophy of the retina; neuritis optici.

9.

The following eye was received from Dr. Mooren, and bore the clinical diagnosis: Ciliary body torn by a weaver's-shuttle; cyclitis; sympathetic irritation of the other eye.

The globe is materially reduced in size. The entrance of the optic nerve and surroundings have been cut off. The corneo-scleral juncture presents a broad cicatrix. After section the following macroscopic appearances are revealed: At the site of the scar both the cornea and sclerotic are curved inwards. The lips of the wounds of both are separated by broad cicatricial tissue, in the formation of which the conjunctiva, iris, ciliary body, and retina seem to participate. This cicatricial tissue traverses the pupil from before backwards, and envelops the iris and ciliary body, and is joined to the retina, which is detached and crowded forwards. The contraction of this tough tissue caused a retraction of the corneo-scleral margin near it and a bulging of the remainder of the cornea.

The corneal epithelium and parenchyma present changes only in the neighborhood of the lesion, where the epithelium is of considerable thickness and several of its cells are in a process of colloid metamorphosis. The corneal lamella adjacent to the cicatrix are separated by spindle-shaped and round cells, which penetrate deeply into the corneal lamellæ, and are accompanied by small vessels. Descemet's membrane is curved outwards at the margin of the wound, and its endothelium appears normal.

The scleral lip of the wound shows the same changes. Spindle-shaped cells project from the cicatrix into the scleral lamellæ (which are curved inwards) and destroy them. The neighboring parts of the sclerotic contain many round cells and numerous vessels.

The contents of the wound, or rather the cicatricial tissue, consist pre-eminently of spindle-shaped cells, intermingled with round cells, considerable quantities of free pigment, and many vessels. The ciliary body and retina are drawn into it, and they participate in the process of cicatrization by proliferation of their cell elements and destruction of their proper structure. Furthermore, the cicatrix contains a part of the capsule of the lens and some lens substance.

That part of the ciliary body which borders on the cicatrix, aside of the distortion of its muscular fibres, exhibits but a sparse increase of round cells. Between its fibres lie many crystals of hæmatoidin.

The cicatricial tissue then proceeds inwards and towards that part of the ciliary body which lies opposite to the cicatrix. It surrounds the iris, which is recognizable only by its pigment. Behind it a mass of fibrin, as yet not organized, is attached to the cicatricial tissue, which contains many red blood-corpuscles and surrounds the convolution of the retina at this part.

That part of the ciliary body which lies opposite the scar manifests rather prominent modifications. It is drawn forwards, and its posterior parts are detached. Its retinal part extends into the scar, and many round cells and crystals of hæmatoidin are found between its muscular fibres. The ciliary nerves are normal. The choroid is hyperæmic. The retinal rods and cones are changed, such as Pagenstecher describes. The cell elements of the retina are less numerous than normal and very granular. The connective tissue elements are much increased. Occasionally free pigment is found in the retina.

Anatomical Diagnosis.—Phthisis bulbi; vulnus corneo-sclerale, the cicatrization of which involves the ciliary body, iris, and retina; plastic cyclitis; traumatic cataract; hyperæmia of the choroid; detachment of the ciliary body and retina; atrophy and pigmentation of the retina.

10.

The following eye was enucleated by Prof. Knapp, for sympathetic irritation of the other:

L. K., æt. 49, states that two years ago a piece of wood was thrown against and broke his spectacles, thus materially injuring the right eye, which remained in an inflammatory condition a long time thereafter. Lately this inflammation recurred, accompanied by severe pain. Simultaneously there was pain in the left eye, with flashes of light and loss of the power of accommodation, all of which symptoms disappeared after the enucleation of the right.

The globe is reduced in size by a diminution of the convexity of the cornea. The latter shows a scar which traverses it diamet-

rically from one margin to the other, passing almost through its centre. Iris and lens are united to each other. The entrance of the optic nerve is excavated, and the nerve very narrow. A gelatinous exudation is found between the retina and choroid and in the vitreous chamber. The lens appears cataractous in its periphery. The epithelial layer of the cornea is thickened, and dips into the corneal parenchyma at several places, especially in the centre, where the cornea is depressed. Bowman's layer is torn in some places and very wavy. From the epithelial cones minute cicatricial cords pass into the corneal parenchyma, one of which passes through its entire substance. Pannous tissue, such as drawn by Pagenstecher, consisting of round cells and vessels, lies between the cornea and its epithelium, at the corneal margin. Bowman's layer is lost in the corneal lamellæ. All the epithelial layers are thickened.

The cicatricial tissue permeating the cornea is darkly pigmented, and contains not only free pigment, but also pigment cells, evidently from the iris. The cicatricial tissue consists essentially of spindle-shaped cells, which pass through the cornea, not only antero-posteriorly, but also send fibres between the corneal lamellæ, thus separating them widely. The iris adheres to the posterior end of the cicatrix, and to Descemet's membrane by a thin layer of spindle-shaped cells (transformed endothelium). In some places, however, where the adhesion is incomplete, the endothelial cells are partly proliferating and partly in a state of colloid degeneration. Descemet's membrane is undulating. In the rest of the corneal parenchyma there is only a small amount of cells.

The tissue of the iris is converted into cicatricial tissue at the site of its attachment to the cornea; its other parts are much thickened and filled with round cells.

In the area of the pupil, the wavy Descemet's membrane is attached to the lens capsule (also wavy and thickened) by means of a layer of tissue composed of spindle-shaped cells. The anterior third of the lens fibres are replaced by spindle-shaped and round cells, and some small vessels, the origin of which cannot be traced.

The products of the metamorphosis of the epithelium of the lens, described as characteristic of phakitis, by Iwanoff and

Becker, are not discernible in this case, as might have been expected. The granulated tissue passes directly into the fibres of the nucleus of the lens, which are normal. The posterior part of the lens has undergone fatty degeneration, leaving no recognizable lens-structure.

The ciliary body is drawn forward. Its fibres are filled with round cells; its muscular structure seems unchanged.

The fibres of the Zonula Zinnii are thickened and covered with many round cells.

The ciliary nerves, as far as they can be followed, appear normal.

The veins of the choroid are hyperæmic. The capillary layer of the choroid contains small round cells. The pigment epithelium is irregular.

The optic disc is a little depressed and contains a great deal of connective tissue. The layer of nerve fibres of the retina is very thin, and its supporting fibres are enlarged. The vicinity of the macula lutea presents many cavities, considered as characteristic of œdema of the retina. They are principally in the inner and outer granular layers, occasionally in the inter-granular layer.

The optic nerve is atrophic, with thickened connective tissue.

Anatomical Diagnosis.—Phthisis anterior; vulnus corneæ, the cicatrization of which involves the retina; cataracta traumatica; iritis purulenta; cyclitis plastica; hyperæmia choroideæ; detachment and atrophy of the retina; œdema of the macula lutea; excavatio atrophica nervi optici.

II.

The following eye was given to Dr. Pooley by a physician of this city, who, some time previously, had made a Graefe's extraction on it. Recently sympathetic irritation of the other eye manifested itself by pain, loss of the power of accommodation and photophobia, in consequence of which an immediate enucleation of the eye first mentioned was made.

The globe is of normal size. The corneo-scleral cicatrix is retracted. Section reveals the following: The anterior chamber is very small. The pupil is drawn towards the scar, and the iris is involved in the cicatrix and surrounded by granulation tissue, to the internal surface of which the posterior capsule of

the lens is attached. The ciliary body and choroid are broader than normal. The retina and the posterior part of the choroid are detached by means of a gelatinous exudation. The retina is still attached to the optic nerve, which is very thin. All the cavities of the globe are filled with a serous exudation.

The microscope reveals the following: The epithelium and parenchyma of the cornea are changed only in the neighborhood of the cicatrix. The corneal and scleral lips of the wound are turned inwards, while those of Descemet's membrane are curved outwards. The corneal lip of the wound is filled with round cells and pigment. Its lamellæ are loosened and traversed by fine vessels. Bowman's layer is wavy. The epithelium is thickened. The scleral wound manifests the same changes as does the corneal, being, however, less infiltrated with round cells. The lips of the wound are separated by iris and granulation tissue, the outer surface of which is completely covered with several layers of epithelium, derived more of the conjunctiva than the cornea. The outer part of the granulation tissue consists mainly of round cells, the inner of spindle-shaped cells. It encloses clusters of epithelial cells and free pigment, and is traversed by vessels. That part of the iris which is enclosed in the wound has no pigment, and is filled with round cells. Its vessels are connected directly with those of the granulation tissue.

The conjunctiva around the scar, and the epi-scleral tissue are full of free pigment and round cells.

The insertion of the ciliary body in the part corresponding to the cicatrix is broad and crowded forwards. Its meshes are replete with round cells, in the production of which the ciliary muscle seems to participate. The ciliary body, at the beginning of its posterior third, is traversed diagonally by cicatricial tissue, which begins from the fibres of the sclerotic, pierces the ciliary body, and then covers its inner surface. The tissue consists of spindle-shaped cells, but contains many round cells; also pigment molecules and the residue of a hemorrhage. At the inner surface of the ciliary body it encloses the fibres of the Zonula Zinnii, and extends to the posterior capsule of the lens, which is stretched transversely through the eye.

A little behind the scar in the ciliary body another similar one is found in the choroid. Its fibres also come from the sclerotic,

are strongly pigmented, pass through the choroid, and form a nodule between the choroid and retina, the size of a pin-head, consisting of tough fibrous, darkly pigmented tissue. The neighboring choroid sends into it a few vessels, which have pigmented coats. The lamina vitrea is markedly undulating, and is broken by the fibrous tissue. These changes, in all probability, are the result of an abscess between the choroid and sclerotic, which involved the inner layers of the sclerotic and opened inwardly. This was materially assisted by the traction which the choroid had been subjected to by the cicatrization.

The choroid is filled with round cells, interspersed with much free pigment, and crowded to clusters in some places. The pigmented epithelium is degenerated.

The ciliary nerves are normal. The retina evinces a connective-tissue proliferation, at the expense of the cell elements of all its layers. The rods and cones have become converted into club-like bodies. The optic disc is œdematous, and the lamina cribrosa thickened. The remainder of the optic nerve appears normal. The exudation in the vitreous is full of round and spindle-shaped cells, and also contains the residues of hemorrhages.

Anatomical Diagnosis.—Incarceration of the iris and capsule of the lens, in the cicatrix, produced by the extraction of a cataract; panophthalmitis purulenta.

12.

The following eye was obtained from Prof. Knapp's collection, and bore the clinical diagnosis: Corneal cicatrix involving the iris. Enucleated for sympathetic irritation of the other.

The globe is remarkably lengthened. The cornea is somewhat flattened. Section shows the periphery of the iris firmly adherent to the corneal cicatrix. Towards the centre it forms a large serous cyst. The remainder of the iris is firmly attached to the cornea. A thin membrane extends from the ciliary body behind the lens, which is pushed forward. In one place the retina, which is partially detached, is united to this membrane. In the posterior part of the eye the changes known as sclero-choroiditis posterior are very pronounced. The optic nerve is deeply excavated.

Microscopical Examination.—The corneal epithelium sends a small conical prolongation into the canal of the scar. The cicatricial tissue which traverses the cornea is pigmented and vascularized. It extends to the anterior capsule (which is torn and folded), and touches the degenerated lens-substance. The lips of the wound of Descemet's membrane are enveloped by the new-formed tissue which forms one wall of the cyst, while the remainder is formed by the sphincter portion and Descemet's membrane. This latter part of the cyst-wall (Descemet's membrane) is covered by a thin layer of spindle-shaped cells. The remainder of the iris is firmly connected with Descemet's membrane, and is so atrophic as to represent a mere strip of pigment. Where the iris forms the wall of the cyst, it curves back with the cicatricial tissue, and inserts itself into the capsule of the lens. The sphincter iridis is preserved, but greatly stretched. The inner surface of the walls of the cyst is lined by the endothelium of the anterior chamber, which is changed, and forms several layers. At those places where the iris adheres to Descemet's membrane a number of endothelial cells are in process of retrogressive metamorphosis. The atrophic iris contains a few diminutive vessels.

Both capsules of the lens are folded, and the anterior is firmly united to the cicatrix. The fibres of the lens have degenerated into a fatty molecular substance, which contains numerous drops of liquor Morgagni.

The contents of the above-described cyst are mainly of a serous nature. Near its walls are small accumulations of large, round and oval, granular and opaque cells, with one or more nuclei, some of which are decaying. That membrane which passes from the ciliary body to the posterior surface of the lens is not a cyclitic new-formation, as it appears macroscopically, but the thickened Zonula Zinnii.

The ciliary nerves are normal.

The choroid, in some parts of its periphery, is completely atrophied and converted into connective tissue. At the same places its pigmented epithelium is destroyed. The vessels of the remaining choroid are very hyperæmic. In the vicinity of the optic nerve the number of pigment cells of the parenchyma of the choroid is reduced, and the pigment granules assume a lighter tint. In a similar manner the vessels lose their regu-

larity, and are separated by broad zones of fine unpigmented connective tissue. The pale pigment cells are found in discrete, irregular clusters. The capillary layer of the choroid has almost completely disappeared. The pigmented epithelium presents the same changes as the pigmented cells of the stroma of the choroid. Though the hexagonal shape of its cells is tolerably well preserved, their pigment becomes the more deficient the nearer they are situated to the optic disc.

The retina which lies over the atrophic patches of the choroid is likewise atrophic. The cellular elements, as well as the nervous fibres in these places, are destroyed, and replaced by very delicate and long connective-tissue fibres, which enclose a few round cells. The optic nerve is deeply excavated. The nervous fibres, here and in the adjacent parts of the retina, are destroyed. The pillars of connective tissue are hypertrophied. The remaining parts of the retina appear normal.

Anatomical Diagnosis.—Sclero-choroiditis posterior; vulnus corneæ, with incarceration of the iris; serous cyst; cataracta traumatica; choroiditis disseminata, atrophica; glaucomatous excavation; atrophy of the retina and of the optic nerve.

13.

The following eye was contributed by Dr. Mooren, and bore the clinical diagnosis: Corneal wound with prolapse of iris; eye enucleated for sympathetic irritation of the other.

The globe is of normal size. Section shows the iris connected with the two ends of a corneal scar. All the cavities of the eye are filled with hemorrhagic exudation. The entrance of the optic nerve is cupped.

The microscope reveals the following conditions: The corneal epithelium is thickened in all of its layers. At both ends of the scar, near the corneal margin, Bowman's layer is absent, and the epithelium sends conical prolongations into the substance of the cornea. A markedly vascularized pseudo-membrane, composed mainly of spindle-shaped cells, is situated between the epithelium and parenchyma. The corneal parenchyma is sclerosed, and its outer-layers only are sparsely vascularized. Descemet's membrane is covered by blood, and its endothelium is undiscernible. Near the scar the broken Descemetii curls inward.

The iris is connected with the cornea by a fibrous, irregularly laminated tissue, and itself is converted into coarse fibres of connective tissue, interspersed with round cells and free pigment. The pupil is obliterated. No trace of the sphincter is perceptible. The "angle of the iris" is infiltrated with blood.

The inner layers of the ciliary body contain a great number of round cells. Its uveal pigment is degenerated, and its retinal part proliferating. The walls of its hyperæmic vessels are thickened. The muscular fibres are separated by serous exudation. The ciliary nerves are unchanged.

The tissue of the choroid contains numerous round cells and hemorrhagic infiltrations. Its vessels, especially the veins, are dilated. The pigment of its parenchyma is pale, but the cells well preserved. The pigmented epithelial cells have lost their regular outlines. Some of them are entirely pale, while others are but partially filled with pigment. At many places colloid excrescences lie upon the lamina vitrea. Most of them contain deposits of amorphous lime. The colloid excrescences are unusually large, and accumulated in such a manner as to resemble the ophthalmoscopic picture of disseminate choroiditis.

The entrance of the optic nerve is cupped. The deepest part of the excavation projects beyond the region of the scleral ring. The fibre-bundles of the lamina cribrosa are thickened and separated by empty cavities. The nervous elements seem to have been completely destroyed here, while behind the lamina cribrosa they resume their normal appearance. The connective-tissue elements of the optic nerve are multiplied. In the parts of the retina surrounding the excavation much areolar connective tissue is found. The layer of nervous fibres of the retina is atrophied and œdematous. Otherwise the retina is normal. At some places, between the retina and choroid, serous exudations and hemorrhages are found.

Anatomical Diagnosis.—Vulnus corneæ with attachment of the iris; atrophy of the iris following plastic iritis; cyclitis; chronic choroiditis with hemorrhages; colloid excrescences of the choroid, with deposits of lime; glaucomatous excavation; atrophy of the optic nerve and retina.

14.

The following eye was enucleated by *Dr. Knapp*, at Heidel-

berg, in 1868. The clinical diagnosis says: Hæmophthalmus; enucleation for sympathetic irritation of the other eye.

The globe is of normal medium size; aqueous and vitreous chambers completely filled with blood. The pupil is dilated to the utmost. The lens is dislocated backward. The retina is detached and pushed forward.

Microscopic investigation shows: The thickness of the cornea is reduced. The epithelium of the corneal margin is considerably thickened, and penetrates into the subjacent tissue, like papillæ. The adjacent conjunctiva presents papillary proliferations, and its congested vessels project abnormally over the corneal margin. A small part of the periphery of the iris is attached to the corneo-scleral tissue. At the same place Descemet's membrane is detached by a slight hemorrhage.

A tough connective tissue surrounds the iris and ciliary body, which is saturated with pigment, and contains a great number of new-formed vessels. A cyclitic membrane extends from the ciliary body transversely through the eye. The detached and atrophic retina adheres firmly to this membrane.

The choroid is thickened, in consequence of a serous exudation, into Haller's layer. The vessels are here replaced by strings of connective tissue, and the pigment cells of the parenchyma are atrophic. The capillary layer is darkly pigmented and hyperæmic.

Anatomical Diagnosis.—Contusio bulbi; hæmophthalmus; luxatio lentis; cyclitis plastica, with hemorrhages; choroiditis serosa; retina detached, and atrophic.

15.

The following eye was enucleated by *Dr. Knapp:* It suffered from acute suppurative iritis, and was removed for sympathetic irritation of the other. In the enucleated globe a foreign body had lodged for twelve years. I described this eye in my contributions to the Pathological Anatomy of the Eye (to appear in the next volume), and shall mention only what is essential for our present purpose.

A splinter of coal lay in the posterior part of the ciliary body and the adjacent sclerotic. It was encapsulated by connective tissue.

In consequence of chronic traumatic inflammation, the retina and choroid are atrophied. Acute purulent inflammation of the entire uveal tract had recently set in. The capsule of the lens was injured; the lens-substance not yet entirely absorbed. The optic nerve was atrophic. The ciliary nerves were entirely normal.

Anatomical Diagnosis.—Corpus alienum in corp. cil. and sclera; old traumatic chorioretinitis, with atrophy; fresh irido-choroiditis suppurativa; atrophy of the optic nerve.

The following forty-two cases of eyes enucleated for sympathetic irritation, recorded in literature, deserve here to be mentioned.

From Graefe's Archiv.

Volume. IV., 1. pp. 363. *Heinrich Müller.*—The enucleated globe shows sclerectasia with irido-choroiditis. The retina is detached. Cataracta capsularis. Ciliary nerves atrophic.

IV. 2, pp. 9. *Iwanoff.*—The globe had suffered a contusion in the region of the ciliary body. There was diffuse suppurative choroiditis.

Ibid.—The globe suffered a severe contusion. There was hæmophthalmus. The connective tissue of the choroid is considerably hypertrophied. The neuroglia of the ciliary nerves is thickened. The nerves contain occasional round cells.

Ibid.—In this eye reclination of a cataractous lens had been performed. The lens lies upon the ciliary processes, and is attached to the iris by new-formed connective tissue. This tissue separates the ciliary body and neighboring parts of the choroid from the sclerotic.

Ibid.—A cataract had been extracted from this eye. Sero-purulent irido-choroiditis. Vitreous turbid.

XX. 1, pp. 97, *Brecht.*—Cicatrix at corneo-scleral margin. Irido-cyclitic membranes have detached the choroid and retina.

Ophthalmic Hospital Report.

IV. 4, pp. 369. *Lawson, Geo.* CASE V.—The eye had been injured eight days previous to the time when sympathetic manifes-

tations necessitated an enucleation. Irido-dialysis and dislocation of the lens into the vitreus are found. Retina and choroid had been detached by hemorrhages.

Ibid. CASE VIII.—Sympathetic irritation appeared three years subsequent to the injury. A scar is found in the ciliary region of the sclerotic. Ciliary body and choroid are in the cicatrix. A foreign body is embedded in the ciliary body. Suppurative cyclitis. Retina detached.

VI. pp. 284, *Vernon, J. B.*—1. Wound in the ciliary body. Sympathetic irritation twenty-five years later. The cicatrix traverses the sclerotic and ciliary body. Thence a dense tissue proceeds inward. Several ciliary nerves project into the cicatrix. Lens absent. Vitreus reduced to a thread of connective tissue. The retina is detached by an exudation, which contains blood and cholesterin.

2. A foreign body, which had passed through the eye, lies behind it upon the optic nerve, and produces severe sympathetic irritation. An iridectomy and cataract extraction had been performed, to reduce the sympathetic irritation upon the other eye. A short amelioration was followed in two weeks by renewed and increased irritation. Then the injured globe was removed. The cicatricial tissue proceeds from the cornea through the iris and vitreus, to be inserted into the optic nerve, surrounding which little hemorrhages are found between the retina and choroid. The globe contains no foreign body, but a piece of a gun-cap is found firmly attached to the optic nerve by new-formed connective tissue.

3. Gunshot wound in the ciliary region. Sympathetic irritation of the other eye. The enucleation was made four weeks subsequent to the injury. The iris is so involved in the cicatrix as to cause the appearance of an iridectomy. The retina is detached at the wound and around the entrance of the optic nerve. The first scar is apparently that produced by the entrance of the foreign body. Not far distant is another scleral cicatrix (exit ?). Both are connected by new-formed tissue.

4. Wound in the ciliary region. Sympathetic irritation of the other eye. The globe was enucleated three months subsequent to the injury. The cornea shows a somewhat indrawn marginal scar, and is dim. The retina is totally detached; also dimmed

and shrunken. Between it and the choroid lies a yellow exudation.

5. Wound in the ciliary region. Rapid sympathetic irritation of the other eye. Enucleation was performed eight days subsequent to the injury. Vitreus and lens have partly escaped. A lacerated wound traverses the entire anterior half of the globe. Fresh hemorrhages lie between the retina and choroid.

6. Puncture from above through the ciliary region. Sympathetic irritation of the other eye. Enucleation five weeks subsequent to the injury. The wound proceeds from the scleral margin, through the cornea, to beyond the pupil. Both angles of the wound contain iris. Opposite a scleral scar involves choroid and retina. Retina and choroid are separated by discolored blood. The lens is absent.

VIII. *Brayley, W. A.*, pp. 561.—The eye was removed seventeen days subsequent to the injury. Sympathetic irritation had existed for ten days. At the outer corneal border a cicatrix, which involves the iris, is found. Lens cataractous. A little piece of iron, covered by new-formed tissue, lies upon the ciliary body. Retina œdematous.

Observations from the Ophthalmic Institute at Wiesbaden, 1862.

Enucleatio bulbi and sympathetic ophthalmia, by Hofr. Pagenstecher, M.D. Autopsies by *Dr. Arnold Pagenstecher.*

Pp. 51–2. (*Autopsy I.*)—Seven or eight years previous to the enucleation, a little stone had been thrown into the patient's eye. Investigation shows chronic irido-choroiditis purulenta. The lens has been absorbed. Retina detached. The stone is attached to the sclerotic by a new-formed tissue.

5. (*Autopsy III.*)—Six years previous to the enucleation the patient was butted in the eye by a cow. The eye is phthisical. The corneal-scar involves the iris. Retina detached. The choroid presents many colloid excrescences, which ossify posteriorly, and further on become transformed into a large bony plate.

6. (*Autopsy IV.*)—Twenty-nine years previous to the enucleation, the patient had a perforating corneal ulcer, which was followed by a chronic irido-choroiditis and calcareous cataract. A fresh keratitis produced so severe a sympathetic irritation of the other eye as to necessitate enucleation. The globe is small. The

cornea presents an ulcer. Iris atrophied. The choroid is ossified at the equator, and completely atrophied at the periphery. Retina detached.

9. Nine weeks previous to the enucleation the eye was injured by a fragment of a percussion-cap. The cornea presents a large cicatrix. There is complete anterior synechia. Lens shrunken. Retina detached. The foreign body lies in the vitreus, surrounded by pus.

12. (*Autopsy XI.*)—Globe atrophic. Grains of powder are found in the ciliary body. Irido-choroiditis (purulenta ?) and a cyclitic membrane are found. The vessels and nerves of the ciliary body manifest no change. The vitreous is purulent.

Annual Report of the Ophthalmic Hospital at Utrecht, 1865.

Page 84. *Maats, J. J.*—1. The eye was lost twenty years previous to the enucleation, in consequence of variola, and has been painful for three years past. The retina is detached and adherent to an irido-cyclitic membrane, and pigmented in spots, especially about its vessels. Points in the choroid, corresponding thereto, are deprived of pigment. The optic nerve is excavated.

2. The eye was destroyed three years before the enucleation. A large quantity of chalk is found in place of the iris and lens. The posterior part of the globe is normal.

4. Sympathetic irritation was produced by an eye which had previously been destroyed by glaucoma, notwithstanding an iridectomy which had been made. Subsequent to its removal, kerato-iritis was found. The iris is atrophied to a great extent, while the ciliary body and retina are completely atrophied.

5. The modifications in this globe were produced by recurrent syphilitic iritis. The iris is atrophied, and behind it some remains of the lens are found. The sclerotic is staphylomatous. The retina and choroid are firmly adherent thereto and atrophied. The retina is entirely detached, and the choroid is attached to it, except around the papilla, where it (the choroid) is detached.

6. Three weeks previous to the enucleation, the cornea had suffered a perforating wound with prolapse of the iris. The iris is firmly adherent to the cornea. The lens is cataractous. A splinter of iron lies upon the choroid. The vitreous and ciliary

body are in a state of suppurative inflammation, and the retina is detached from the entrance of the optic nerve.

8. The disease of the eye lasted twelve years previous to the enucleation, and it has been blind for nine years. It had been subjected to iridectomy and extraction of cataract. Thereupon irritation in the other eye supervened, which was iridectomized because of increased tension. The iris is adherent to the corneal margin. The retina is detached, and lies against the iris, enclosing four large chalky concrements, which rest upon the ciliary body. The choroid is much shrunken, and its periphery is also calcified. A cyclitic membrane is found.

16. The eye had been injured six weeks previous to enucleation. The anterior chamber is filled with pus. Purulent cyclitic masses are united with the capsule of the lens. The retina is detached and atrophic. The vitreus is filled with pus, which enclosed two fragments of copper.

Sympathische Gesichtsstörungen. (Sympathetic Affections of the Eye.) *By Dr. Mooren*, 1869.

Page 129, *Schiess-Gemuseus.*—An artificial eye was worn upon the blind globe, for two years previous to the enucleation. Sympathetic irritation was combined with epileptic attacks. A ciliary membrane encloses the fragment of a percussion-cap. The outer layers of the ciliary body are closely adherent to the sclerotic. The lens is shrunken, and encircled by the detached retina. The choroid is ossified around the optic nerve. The neurilemma of the ciliary nerves contains chalky concrements.

Iwanoff, ibid., p. 161.

To p. 38.—The globe was destroyed in consequence of iridochoroiditis gummosa. It is atrophic. The iris is attached to the ciliary processes and anterior surface of the cataractous lens, by a new-formed tissue, and its papillary margin is swollen. The ciliary body is much thickened. Its meshes are filled with round cells, the muscular portion participating actively in their formation. It also has a number of new vessels. The neighboring parts of the choroid are infiltrated with cells; the remainder is hyperæmic. The retina is œdematous, with proliferation of its connective-tissue elements. The structure of the iris is destroyed, its tissue having been converted into a mass of round

cells. Schwann's sheath of the ciliary nerves is thickened, and its nuclei are swollen.

Ibid. to p. 46.—An abscess of the cornea, with prolapse of the iris, occurred seventeen years previous to the enucleation. There is phthisis anterior. The iris is involved in the corneal cicatrix, and in its entire extent is attached to the cornea, which is converted into cicatricial tissue. The ciliary body is much thickened, and so drawn inwards by a cyclitic membrane that its posterior part and the neighboring choroid are detached. The lens is much shrunken, and attached to the iris and cornea. The retina is atrophic, with a partial obliteration of its vessels. The choroid presents colloid excrescences. Aside of these results of old inflammations, a new inflammatory process has set in. The periphery of the iris, as well as the ciliary body, the vitreus and the sclerotic about the plexus venosus are filled with round cells strongly vascularized. The connective tissue of the ciliary body is hypertrophied, and the course of its muscular fibres changed. The retraction of the cyclitic membrane caused its detachment from such places where the ciliary body is attached to the retina, thus forming cavities between the pars ciliaris retinæ and ciliary body, filled with an exudation pressing upon the ciliary body (!). Round cells fill the periphery of the retina.

Page 104.—The eye became phthisical, in consequence of the extraction of a cataract. Notwithstanding this clinical statement, the volume of the ball seems increased. The cicatrix of the wound caused by the extraction contains some iris and remnants of the capsule. The cicatricial tissue is attached to a cyclitic membrane, which, in its retraction, has drawn all the membranes towards the scar, and has caused a detachment of the opposite part of the ciliary body from the sclerotic. The vitreus is filled with an exudation.

Provincial Medical and Surgical Journal.

1851, p. 66, *Prichard, Aug.*—The eye was enucleated thirteen years ago, subsequent to the injury. The lens is absorbed, and the capsule presses (!) upon the ciliary body. The choroid is separated from the sclerotic by a thick, firm mass of fibrin, which is pierced by a ciliary artery and a stretched ciliary nerve; otherwise it appears healthy. The retina is healthy. No foreign body can be found in the globe.

Annales d'Occulistique.

1860, p. 150. *Case of Dixon;* examined by *Bader.*—Five years previous to the enucleation the eye had been injured and its vision destroyed. The anterior chamber is filled with blood and yellow fluid. The vessels of the iris are "varicose." The posterior surface of the iris is completely attached to the (cataractous) lens. The retina is detached.

Archives of Ophthalmology and Otology.

II., 1, pp. 16, *Knapp, Herman.*—The eye was enucleated five years subsequent to an injury of the cornea, iris, lens, and the ciliary body. Plastic iritis and cyclitis are found. The retina is detached. The choroid is ossified.

Archiv für Heilkunde.

1871, p. 226, *Peppmüller, Felix.*—The globe was examined by *Leber*, after it had been enucleated by *Alfred Graefe.* At the time of the operation, vision was almost normal. The ciliary body is normal, though a piece of a percussion-cap lies upon it. The pars ciliaris retinæ is thickened, and a small part of the neighboring vitreus is purulent. There is connective-tissue proliferation around the entrance of the optic nerve.

Schussverletzungen des Auges. (Gunshot Wounds of the Eye.) *By Cohn, Herm.*

CASE 28, p. 25, *Waldeyer.*—The eye was enucleated about six months subsequent to an injury of the zygomatic process, etc. The following conditions presented themselves: Chronic chorio-retinitis, with atrophy of the choroid and a plastic exudation upon the retina undergoing fibrous degeneration.

CASE 31, p. 30.—The enucleation was performed six months after the injury. *Waldeyer's* examination of the globe showed no pathological change, except one hemorrhage and the formation of folds in the macula lutea.

Injuries of the Eye, Orbit and Eyelids.
By George Lawson.

Page 214, CASE XLIV.—A scar in the ciliary region of the sclerotic unites with it the ciliary body and choroid. A metallic splinter, surrounded by pus, rests upon the ciliary body. The lens is cataractous, the retina detached.

Ibid., CASE LXI.—The ciliary region of the sclera presents a large cicatrix. The lens and iris are absent. The vitreus is filled with blood; extensive hemorrhages are found between the retina and choroid, and between the choroid and the sclerotic.

Ibid., with fig. 67.—The globe had been injured thirty years previous to the enucleation. The choroid is ossified around the entrance of the optic nerve. The retina is detached.

Ibid., CASE LXXIV.—The eye was destroyed, apparently by blennorrhœa, sixty years previous to the enucleation. The cornea is converted into cicatricial tissue, and infiltrated with chalk. Almost the entire choroid is ossified. The retina is detached in the common funnel-shaped condition.

II.

EYES ENUCLEATED FOR SYMPATHETIC IRITIS.

16.

The following globe was enucleated by *Dr. Pooley*, for sympathetic iritis, which had supervened in the other eye.

The globe is reduced in size, from flattening of the cornea. The sclerotic is depressed towards the axis of the globe in several places. Transverse section shows the iris attached to the cornea; the lens cataractous in its periphery; posterior part surrounded by a cyclitic membrane, to which folds of the completely detached retina are united. The choroid is much thickened, especially at the points where the sclerotic is depressed, and firmly adherent to the sclerotic. The optic nerve is very thin. All the cavities of the globe are filled with a purulent exudation.

The microscope shows the cornea to be converted into dense cicatricial tissue, and covered by conjunctiva filled with round cells. Descemet's membrane is undulating, and its endothelium at several places is transformed into spindle-shaped cells.

The peripheral part of the anterior chamber is preserved, but shallow in the centre. The iris adheres to Descemet's membrane by layers of spindle-shaped cells.

The iris is saturated with round cells, and shows but few vessels. Its uveal pigment is distributed irregularly. The posterior surface of the free part of the iris, attached to Descemet's mem-

brane, the ciliary body, and the posterior capsule, are covered by an accumulation of round cells, into which the retinal part of the ciliary body has proliferated.

The ciliary body is converted into a fibrous tissue, which presents many cavities filled with an exudation, few remnants of its muscular tissue, and very few vessels.

The choroid is changed into a tissue of very fine fibres, which has only a small number of vessels, and is filled with free pigment. The pigmented epithelium is well preserved everywhere. The choroid, around the entrance of the optic nerve, is completely atrophied. The pigmented epithelium is found to be separated from the sclerotic only by a minute layer of fibres.

The ciliary nerves cannot be found. They seem to be entirely destroyed.

The retina, which is detached, and has undergone connective-tissue degeneration, presents mere traces of the granular layers. It is pigmented in spots, without any typical arrangement.

The connective tissue of the optic nerve is considerably thickened. Its nervous fibres, much reduced in number, are occasionally dimmed by fat.

Anatomical Diagnosis.—Phthisis bulbi; vulnus corneæ; synechia anterior; iritis purulenta; cyclitis serosa et plastica; choroiditis chronica hypertrophica; atrophy of the detached retina and the optic nerve.

17.

The following eye was enucleated by *Dr. Pooley* for iritis serosa sympathetica of the other. The size of the globe is reduced from flattening of the cornea. The entire cornea is covered by conjunctiva. The iris is firmly attached to the posterior surface of the cornea, and its posterior surface is covered by a cyclitic membrane with which the peripheral part of the retina is connected. The retina is detached in the shape of a funnel. The ciliary region seems to contain some osseous tissue. The ciliary body is atrophic. The sheath of the optic nerve is thickened.

Microscopic examination reveals the following: The cornea, barely recognizable as such, is covered by a thick conjunctival layer, which is strongly vascularized and covered with papillary elevations. The corneal epithelium and Bowman's layer are destroyed. The corneal tissue is converted into connective tissue,

without any lammellation, which contains vessels and much free pigment. Descemet's membrane is wavy. A mass of new-formed tissue lies on its posterior surface, which is barely distinguishable from that of the cornea. Some clusters of iris pigment are the only remains of that membrane. Immediately behind, the retina is found attached to the new-formed tissue.

The ciliary body is reduced to a microscopic layer of muscular tissue. Its uveal pigment is drawn into the surrounding new-formed tissue. Upon and within this lies the periphery of the retina, which is bent forward and pigmented.

The new-formed membrane and the retina contain many osseous islets, which are mostly grouped about vessels and surrounded by pigment.

This strange location of osseous deposit in the retina I had never seen before. The condition finds its explanation in the presence of colloid excrescences in the choroid, afterward to be described. It is found in eyes which present colloid excrescences upon the choroid, that when the retina is detached from the choroid, a number of the excrescences adhere to it. Furthermore a number of cases have been described wherein these colloid excrescences were the starting-points for ossification. According to *Knapp's* theory, one should assume that the retina had been saturated by a choroidal exudation, which afterwards became converted into bone.

Otherwise the retina is completely degenerated into connective tissue, and contains much free pigment, hæmatoidin, and lime-phosphates.

The choroid is very atrophic. Upon the lamina vitrea lie many colloid excrescences. The pigment epithelium is changed in such a manner that it perhaps might throw some light upon the formation of the colloid excrescences. Its cells have lost their regular shape. In a number of cells one or more round cavities are found, which crowd the granular pigment aside. These changed cells become confluent occasionally. Then a number of such cavities are surrounded by a thickly-pigmented ring, and separated from each other by minute streaks of pigment. The whole process is analogous to colloid metamorphosis. At such places where these changes are the most advanced, a greater or smaller number of colloid excrescences are found, sur-

rounded by pigment. It would thus appear as though the formation of colloid excrescences should be viewed as a metamorphosis of the pigment epithelium. Whether it be colloid matter, or what else, with which the cells are infiltrated, I cannot say (cf. Donders).

The pigmented parenchyma cells of the choroid are very pale, and have lost their sharp contours.

The ciliary nerves show no pathological change.

The optic nerve is atrophic.

Anatomical Diagnosis.—Phthisis anterior; vulnus corneæ; atrophy of the iris and ciliary body after plastic irido-cyclitis; detachment and ossification of the periphery of the retina; colloid (?) metamorphosis of the pigment epithelium; colloid excrescences upon the choroid; atrophy of the choroid, retina, and optic nerve.

18.

The following globe was enucleated by *Dr. Knapp*, in Heidelberg, for sympathetic iritis in the left eye. The record of this case states merely that C. M., æt. 18, could count fingers with the left eye, at four feet, previous to the enucleation (2, VII., 68) and was discharged three weeks later with a visual acuity of $\frac{20}{70}$.

The globe is smaller than usual. The cornea presents a marginal scar, around which it is flattened. Section shows the ciliary body, iris, and lens to be attached to the cicatrix. The opposite side in the meridional sections shows the posterior surface of the iris to be attached to the ciliary body. The remaining part of the anterior chamber is filled with a serous exudation. Posterior to the lens, a delicate cyclitic membrane passes diagonally through the globe. The whole retina is detached, except around the optic nerve and at its periphery. The optic nerve is attenuated, and the sclerotic is thickened around the optic nerve entrance.

The following conditions are discovered by the microscope: The epithelium around the cicatrix is thickened, and sends papillary prolongations into the tissue of the cornea. Bowman's layer is corrugated. The cicatricial cord is very broad, and contains many round cells. The neighboring corneal lamellæ are distorted and vascularized. Descemet's membrane is curved outwards into

the canal of the cicatrix. The cicatricial tissue is connected with the remains of the iris. The iris, the ciliary body, and the neighboring choroid are disorganized in the same manner, forming a continuous stratum of round cells, interspersed with remnants of pigment.

That opposite part of the iris is firmly united with the apices of the ciliary processes thinned. The adjacent iris is stretched, and contains numerous round cells.

The equatorial part of the capsule of the lens which lie near the corneal-scar is retracted and folded. It is covered by a layer of spindle-shaped round cells and vessels, proceeding from the cicatrix, and reaching beyond the poles of the lens. As far as this layer follows the inner surface of the anterior capsule, no lens epithelium is found; beyond this it is preserved unchanged. The spindle-shaped cells enclose a layer of destroyed lens substance and a nucleus of normal lens fibres.

That part of the equator of the lens which lies opposite the scar shows no pathological changes. The lens fibres and their granulated nuclei are clearly seen. The Zonula fibres of this side pass unchanged from the capsule to the ciliary body.

The adjacent part of the ciliary body is filled with round cells, which enclose a number of crystals of hæmatoidin. The retinal part in this place is much proliferated, and participates in the formation of a thin cyclitic membrane, which passes behind the lens to the cicatricial tissue of the other side. It presents fresh hemorrhages, many round cells, and some fatty detritus (probably remains of the lens, which escaped from the capsule).

The ciliary nerves show no pathological change whatever.

The posterior parts of the choroid are thickened everywhere. The parenchyma has lost its peculiar structure, being converted into a mass of round cells, which encloses the remains of the destroyed pigment cells. Between the choroid and retina a seropurulent exudation with fresh blood-clots is found.

The thickened sclerotic is contracted around the optic nerve. Its vessels are hyperæmic, and their lymph-sheaths dilated. The lamina cribrosa is thickened. Immediately after the entrance of the optic nerve the retina is detached. The papilla is thickened by connective-tissue proliferation. The layer of nervous fibres of the retina is œdematous. The ganglionic cells are remarkably

few in number. The other retinal layers manifest an increase of round cells. Round cells are also to be seen in the peripheral parts of the layer of nervous fibres and the inner layers of the sclerotic.

Anatomical Diagnosis.—Phthisis anterior; vulnus corneo-sclerale, with imprisonment of the iris, ciliary body, and lens; cataracta traumatica; iritis purulenta; cyclitis plastica et purulenta; choroiditis purulenta; detachment of the retina; retinitis; atrophy of the retina and optic nerve.

19.

The following eye was enucleated by *Dr. Knapp* for sympathetic iritis. Ch. E., æt. 17, had suffered an injury of the left eye two years previously, and three months preceding the enucleation was the subject of sympathetic iritis in the right eye. The globe is small. The centre of the cornea presents a cicatrix, to which the iris is attached. The ciliary body is atrophic. The lens seems to be absent. The retina is detached, and crowded forward. The posterior section of the sclerotic is much thickened. The anterior chamber is filled with blood, and the vitreous space with a serous exudation.

The microscope reveals the following: The cornea is of nominal thickness, and a little sunken in its centre. The epithelial layer is somewhat thickened in the centre of the cornea, and penetrates Bowman's layer. Thence a narrow strip of cicatricial tissue passes almost perpendicularly through the vascularized cornea. Descemet's membrane is curved outward into the canal of the wound. Its endothelium is normal only in its periphery, and, as it approaches the scar, it becomes transformed into a fine tissue composed of spindle-shaped cells, which is continued over the anterior surface of the iris. The entire anterior chamber is filled with fresh blood.

The periphery of the iris on both sides (meridional sections) is attached to Descemet's membrane, and infiltrated with extravasated blood. Thence it proceeds, as an atrophic strip of connective tissue, towards the corneal cicatrix. Just before its insertion it is much swollen, folded, and saturated with round cells. No vestige of the sphincter iridis remains. The uveal pigment of the iris is loosened, and protrudes, in narrow

strips, into the serous exudation which fills the vitreous chamber.

The ciliary body is atrophied. Its muscular fibres are compressed.

The ciliary nerves are well preserved, and show no pathological changes.

The choroid, near the ciliary body, is atrophic. The remainder of it is very hyperæmic, and rather thickened. Upon the lamina vitrea choroideæ lie a few colloid excrescences.

The ciliary part of the retina is somewhat thickened, and firmly united to the rest of the retina, which is detached, and converted into connective tissue.

Anatomical Diagnosis.—Phthisis anterior; vulnus cornea, with imprisonment of the iris; atrophy of the entire uveal tract; detachment and atrophy of retina.

20.

The following eye was given me by *Dr. Knapp*. It was enucleated for sympathetic iritis serosa of the other eye.

The record shows that K. B., æt. 9, had thrust a pin into his eye seven years ago. The subsequent inflammation subsided under the care of a physician. He presented himself May 24, 1876, with the following conditions: *Left*—Irido-choroiditis chronica, with complete synechia and total loss of vision. *Right*—Iritis serosa sympathica. The enucleation was followed by such rapid improvement that the patient could be discharged the 29th of the same month. He soon returned, however, with a renewed inflammation in the form of irido-cyclitis plastica. His vision, which had been normal, had sunken to $\frac{2}{200}$. There was complete circular synechia. The eye improved under the ordinary treatment. The effort to improve sight and the conditions of the eye by an iridectomy proved futile to a certain extent, because the coloboma slowly closed again. He was discharged in the middle of July, without any inflammatory manifestations. V = $\frac{20}{200}$. Prognosis doubtful; rather unfavorable.

The globe is reduced in size, and the cornea flattened. Section shows the corneal tissue to be much thickened. The iris is firmly attached to the cornea. A cyclitic membrane traverses the eye behind the iris, and is connected with the detached retina. A small quantity of a flocculent fluid is found between retina and choroid. The inner surface of the choroid is studded with gran-

ules. The optic nerve is very thin. The sclerotic is thickened, especially around the entrance of the optic nerve. No vestige of the lens is perceptible.

The microscope reveals the following: The epithelium of the cornea is somewhat thickened at the site of the old cicatrix. Beneath this a tough, laminated cicatricial tissue is found, which extends as far as Descemet's membrane, and is markedly different from the normal corneal tissue. The rest of the corneal parenchyma is more or less thickened, and also manifests an irregularly laminated structure. The number of its cell elements is materially reduced. There is a slight degree of vascularization. Descemet's membrane, to which the iris is firmly adherent almost everywhere, is drawn towards the centre of the cornea. Its endothelium is substituted to a great extent by delicate, spindle-shaped cells, which unite it with the iris. The spindle-shaped cells are evidently transformed endothelium cells of Descemet's membrane and of the anterior surface of the iris. This can be clearly demonstrated at such places where the adhesion is not complete. Many endothelium cells there are seen to be stretched, and others are converted into complete spindle-shaped cells. Besides the spindle-shaped cells, many round cells are found, and nuclei without protoplasma.

The periphery of the iris and the ciliary body are drawn towards the centre of the cornea. The pupil is completely occluded. The parenchyma of the iris is thickened, and replete with round cells. The number of vessels is reduced, while their calibre is considerably increased. The pigment cells of the parenchyma are destroyed, and their pigment is free. The uveal pigment is considerably spread out, and irregularly arranged. No trace of the sphincter iridis. The posterior surface of the iris is covered by a dense cyclitic membrane, which has a laminated structure, resembling that of the corneal tissue. It is vascularized and encloses between its fibres some free pigmented and round cells; between the iris and the cyclitic membrane a small part of the capsule and lens substance is found. The latter is almost entirely calcified.

The parenchyma of the choroid is less filled with round cells than the iris and ciliary body. The pigment cells are decaying, and the pigment is scattered about. The choroidal vessels

are mostly distended with blood. The lamina vitrea is studded with colloid excrescences. In some places they are so numerous as to cover the entire field of vision, and are separated only by a string of epithelial cells. They abound and are chalky near the entrance of the optic nerve; whereas towards the periphery they are scarce, and are almost free from lime.

Notwithstanding the suppurative inflammation of the entire uveal tract, the ciliary nerves show no pathological change.

The retina is almost entirely transformed into connective tissue. Its folds enclose vitreous substance, pigment, and the colloid excrescences of the lamina vitrea choroideæ. This last condition justifies a presumption that the formation of the colloid excrescences preceded the retinal detachment. Furthermore, a number of chalky concrements are found in the retina.

The entrance of the optic nerve is contracted. The lamina cribrosa consists of large bundles of coarse connective tissue, through which no nervous fibres pass. Behind the sclerotic the nervous fibres are again visible, and there are surrounded by proliferating connective tissue.

A small quantity of a thin flocculent fluid is found between the detached retina and choroid. The flocculi consist of little bodies of protoplasm, free nuclei, and little drops of fat. The globules of protoplasm contain pigment granules, and vary greatly in shape and size, some having but twice or thrice the diameter of white blood-corpuscles, others twenty or thirty times. Some have a nucleus. I do not know which is the origin of these protoplasmic masses.

Anatomical Diagnosis.—Phthisis anterior; vulnus corneæ; synechia anterior totalis; cataracta calcaria; irido-choroiditis purulenta; colloid excrescences, with chalky deposits; detachment and atrophy of retina; atrophy of the optic nerve.

21.

The following eye was enucleated by *Dr. Knapp*, in Heidelberg. The record says:

J. A., æt. 31, presented himself at the hospital, April 4, 1867. He stated that his eye had been injured several days previously by a piece of wood. *Stat. præs.* At about 1‴ from and parallel to the corneal margin a laceration of the cornea, 3‴ in length, is found, which is filled

with prolapsed iris. The iris is moderately inflamed, the lens swollen and opaque; marked ciliary injection. The patient was admitted to the hospital, and treated there nineteen days; when he left, marked ciliary injection was still present. On May 28, he returned and stated that, soon after his discharge, the right eye manifested photophobia, some redness and pain, which increased *pari passu* with the decrease of vision.

Present condition L.: Near the corneal margin a vertical scar 3''' long enclosing iris; pupil medium, dull, grayish-white on the nasal, and yellowish-red on the temporal side; circum-corneal injection least marked above; iris hyperæmic and discolored; intense photophobia; no particular painfulness upon pressure in the ciliary regions; perception of light without correct projection. *R.:* Photophobia; pain spontaneous and upon pressure; circum-corneal injection; aqueous humor turbid; pupil contracted; iris swollen and very hyperæmic; fundus not illuminable; fingers counted at 3′ with difficulty. Tn.

Dr. Knapp enucleated the eye the same day. Patient was discharged, on the 16th of July, with complete occlusion of the pupil.

The globe is rather under normal size, from flattening of the cornea. A somewhat indrawn scar is found near the corneal margin. Section shows the iris thickened and its periphery caught in the cicatrix. The opposite side of the ciliary body detached, drawn forward and inward, which is probably in consequence of the retraction of a broad cyclitic membrane. The choroid is considerably thickened, especially in its posterior part. The retina is united with the ciliary membrane, is detached in shape of a funnel, and its folds seem thickened. The sclerotic is thickened in such a manner as materially to contract the entrance of the optic nerve.

Microscopic Investigation.—The corneal scar consists of a funnel-shaped strip of tissue, which traverses the corneal tissue, and is of irregularly laminated structure, and strongly vascularized. Bowman's membrane accompanies the cicatricial tissue, on both sides, for a short distance. It encloses much free pigment, vessels, one cilia, and many round cells. The cilia is surrounded by a simple layer of epithelial cells.

At the posterior surface of the cornea, the wavy Descemet's membrane is partly enveloped in new-formed tissue. The cicatricial tissue is continued through the periphery of the iris and

united with a cyclitic membrane. Then it encloses the capsule of the lens, which is much folded. In lieu of the lens substance, the folds, especially those of the anterior capsule near the wound, enclose a dense tissue composed of round and spindle-shaped cells.

The parenchyma of the iris is thickened to about three times its size. Upon its posterior surface is a tissue directly connecting with and completely resembling that enclosed by the lens capsule. The anterior surface of the iris is markedly undulated. The iris tissue is sparsely vascularized, and filled with round cells. Its pigment cells are destroyed, and their free pigment lies scattered about among the round cells. The cells of the uveal pigment are detached, and their pigment is free to a great extent.

The ciliary body is densely packed with round cells, and its muscular structure somewhat reduced. The few vessels discernible are hyperæmic. The part of the ciliary body near the wound has maintained its normal relationship to the sclerotic, while the opposite part is detached, and at the same place the periphery of the iris is torn. The muscular fibres of the ciliary body do not seem to have participated in the pyogenic process. The retinal part of the ciliary body is thickened and united with the corneal cicatrix, by means of a dense connective tissue, into which the uveal pigment of the ciliary body is drawn.

The parenchyma of the choroid is much thickened and filled with round cells. The pigment epithelium and the pigmented cells of the parenchyma are undergoing destruction. Those of the latter cells which are preserved are abnormally small and darkly pigmented, and, while their pigment is remarkably granular, no nucleus can be found. Free pigment is scattered about everywhere. These changes are more expressed in the chorio-capillary than in the outer choroidal layers. The vessels, reduced in number, are dilated and hyperæmic. The somewhat undulating lamina vitrea is easily recognizable.

The ciliary nerves are normal everywhere.

The lamina fusca is filled with round cells, and its pigment shows the changes that were found in the choroid.

The layer of nervous fibres of the retina shows an abundant infiltration of round cells. This is the case with the outer layers,

thus permitting no differentiation between the inner and outer granular layers, but representing a mere mass of round cells. The ganglion cells appear atrophied, and several have been converted into hyaline vesicles (colloid ?).

The optic disc and nerve show a considerable thickening of their connective-tissue elements. The nerves are atrophied, and have undergone partial fatty degeneration.

The sclerotic is thickened. The ciliary nerves, where they pierce the sclerotic, are normal.

Anatomical Diagnosis.— Phthisis anterior; vulnus corneo-sclerale with incarceration of the iris; panophthalmitis purulenta; neuritis, with beginning atrophy of the optic nerve; cataracta traumatica; detachment of the ciliary body.

The following nine eyes were enucleated on account of sympathetic iritis, and are described in literature.

Graefe's Archiv.

IV. 1, p. 363, *H. Müller.*—The globe is atrophied. The cornea presents a cicatrix, from which new-formed tissue extends backwards, envelopes the iris and ciliary body, and draws the ciliary body inward. Irido-choroiditis. The optic nerve has undergone granular and fatty degeneration.

VI. 1, p. 134, *C. Schweigger.*—Corneal scar. Lens is much swollen, containing a foreign body; chronic choroiditis.

VI. 2, p. 267, *C. Schweigger.*—An iridectomy had been performed. The iris lies in the cicatrix produced by the iridectomy. Purulent irido-cyclitis.

Klinische Monatsblätter.

1869, *Hirschberg.*—The globe was enucleated eight weeks after having received a contusion. It presents a corneal scar, to which the iris is attached by means of new-formed connective tissue. At the juncture of choroid and ciliary body, the choroid is detached. A cyclitic membrane proceeds from ciliary body through the globe. The supra-choroidal space is filled with an exudation. The ciliary nerves are normal.

Ophthalm. Hosp. Rep.

VI., p. 284, *Vernon, J. B.*—Five weeks previous to the enucleation the globe had received an injury to the ciliary region; a

prolapse of the iris was removed. The cicatricial tissue penetrates the sclerotic the entire thickness of the ciliary body, and proceeds inward attached to the iris. Lens absent. The vitreous space contains a yellow fluid.

Klin. Beobachtungen aus der Augenheilanstalt in Wiesbaden, 1862.—*Enucleatio bulbi, etc., by Hofr. Pagenstecher, M.D.; and Autopsies, by Dr. A. Pagenstecher.*

Page 54, 3.—Three years previous to the enucleation, reclination of a cataract had been performed. The cataract is found attached to the choroid by a new-formed tissue. The retina is detached.

Ibid. 4. (*Autopsy II.*)—Three years previous to the enucleation, division of a cataractous lens had been performed, and chronic irido-choroiditis supervened. After sympathetic manifestations had appeared in the other eye, an iridectomy was made. This was five weeks preceding the enucleation. Irido-choroiditis plastica and serosa. The pupil is closed by a new-formed membrane, which is partly ossified. The retina is detached.

Mooren. Sympathische Gesichtsstörungen.

To p. 83, *Iwanoff.*—Sympathetic manifestations followed an iridectomy for secondary cataract. The globe is much atrophied. In its lower and outer part, a capsulated piece of iron is found, which is attached to the ciliary body, choroid, and retina. The cornea is flat and thickened; in its centre there is a large cicatrix, which is united with the vitreous, the torn lens-capsule, and the iris. The other side of the iris is drawn towards the cicatrix. The remainder of the anterior chamber is filled with blood and pus; the ciliary body and adjacent choroid are detached and drawn forward. The ciliary body at the location of the foreign body is atrophied, and infiltrated with cells. Between it and the sclerotic there is a newly-formed membrane, in which the ciliary nerves are lost. Schwann's sheath of the nerves is thickened.

Boston Medical and Surgical Journal.

IV. Page 5. *Handy.*—The enucleation was made thirteen weeks subsequent to the injury. The vitreus has been converted into dark fluid. The lens is shrunken, and lies against a

corneal cicatrix. Thence a new-formed membrane proceeds to the ciliary body, which contains a small fragment of steel. The retina is detached.

III.

GLOBES ENUCLEATED FOR SYMPATHETIC IRIDO-CYCLITIS.

22.

The following eye was enucleated by *Dr. Pooley* on July 26th, 1875, for irido-cyclitis sympathica, and under the presumption that it contained a foreign body.

The globe is very small. A deeply-indrawn scar penetrates the centre of the cornea. After the section, it is seen that the scar is surrounded by a ring of anterior chamber, and connected with a dense cyclitic membrane, which envelops the ciliary body and draws it forward and inward towards the axis. Thus the posterior part of the ciliary body and the choroid are detached. The iris and lens are absent. The retina, around the entrance of the optic nerve, is detached. The optic nerve is atrophied. The cavities of the globe are filled with a serous fluid.

Microscopic Investigation.—The epithelial layer of the cornea is thickened, especially at the cicatrix, and at the same place Bowman's membrane is folded. The corneal lamellæ appear normal, but are pierced by a broad, strongly vascularized, cicatricial tissue composed of spindle-shaped and round cells. Descemet's membrane is remarkably thin. Its endothelium is well preserved and normal. The cicatricial tissue within the cornea contains remnants of the capsule.

The iris has entirely disappeared.

The insertion of the ciliary body is broader than normal. Upon it lies a tough cyclitic membrane, which is of a partly lamellar arrangement, and has only a few vessels. It implies the pars-ciliaris retinæ. The uveal pigment passes inward through the fibres of this membrane, which unites with the cicatricial tissue of the cornea. Remains of the capsule of the lens and the periphery of the retina, which has undergone connective tissue degeneration, are attached to its posterior surface.

The tissue of the ciliary body is much atrophied. Its vessels are partly hyperæmic.

The choroidal tissue shows the consequences of a chronic hyperæmia. Its veins are enlarged, and between them lies much connective tissue. Its pigment cells, as well as those of the pigment epithelium, are hardly changed.

The cellular elements of the retina are destroyed by formation of connective tissue. The ganglionic layer shows many cells which have undergone colloid degeneration. The entrance of the optic nerve abounds with connective tissue and vessels. The latter are filled with blood. The lamina cribrosa is much hypertrophied, and but few nervous fibres remain discernible.

The ciliary nerves do not manifest the least pathological change.

Anatomical Diagnosis.—Phthisis bulbi traumatica; entire absence of iris and lens; atrophy of the ciliary body, resulting from cyclitis plastica; detachment of the ciliary body and of the periphery of the choroid; chronic hyperæmia of the choroid; detachment of the retina; atrophy of the retina and optic nerve.

In literature I find that the following three eyes were enucleated for sympathetic irido-cyclitis:

Graefe's Archives.

XIV., 2, p. 328. *Berlin.*—The eye was glaucomatous, and an iridectomy has been performed. After enucleation, melano-sarcoma of the choroid was found.

Utrechter Jahresbericht, 1865.

Page 41. *Maats, J. J.*, 3. The eye had become staphylomatous, in consequence of burning of the cornea. Six months after the burn the staphyloma was removed. Fourteen days later the eye was enucleated. The globe is phthisical. The vitreus contains pus. The retina is detached.

Injuries of the Eye, Orbit, and Eyelids. Geo. Lawson, 1867.

Page 214. CASE LXX.—Ten months previous to the enucleation the eye had suffered an injury to the cornea, with prolapse of the iris. The retina is œdematous, its connective tissue

swollen, especially its radial fibres. The choroid also is œdematous, and shows purulent infiltration. The pigment epithelium is swelled and partly destroyed. The vitreus contains a fibrinous exudation.

IV.

GLOBES ENUCLEATED FOR SYMPATHETIC IRIDO-CHOROIDITIS.

23.

The following eye was received from *Dr. Mooren*, and accompanied by the clinical diagnosis: Amaurosis following choroiditis traumatica, with persistent cyclitis; sympathetic ophthalmia of the other eye.

The globe is of normal dimensions. The corneo-scleral margin presents a small cicatrix. Section shows the iris to be drawn towards and healed into the scar. The anterior and vitreous chambers are filled with a gelatinous exudation, which is saturated with extravasations. The retina is partly detached. The entrance of the optic nerve is considerably thickened, but compressed in the scleral aperture.

The microscope reveals the following: The corneal tissue is vascularized, especially in its outer layers. The epithelium is thickened, and dips into the corneal substance at the cicatrix. Bowman's layer cannot be recognized. A tissue, composed of long, spindle-shaped and round cells, and many vessels, is found under the epithelium. At the point where the cicatrix pierces the cornea the layers of the latter are curved outward. The cicatricial tissue consists of delicate, spindle-shaped and round cells and new vessels. The iris lies in it, and its vessels connect with those of the cicatrix.

The parenchyma of the iris is replete with round cells. Its pigment is scattered about, and its vessels are engorged.

The lips of the wound of Descemet's membrane are bent outward into the canal of the wound.

In quite a number of sections taken from the place of attachment of the iris a great accumulation of epithelial cells is found, evidently thrown into the wound-canal where the injury occurred.

The free part of the iris is also densely filled with round cells.

The ciliary body shows an extensive production of round cells, and its vessels are greatly dilated. Its retinal part is slightly thickened.

The lens is wanting.

The ciliary nerves near the wound and in other parts of the eye are entirely normal. Occasionally a fibre is somewhat opaque by fatty infiltration.

The choroid is very hyperæmic. Along the vessels a sparse accumulation of white corpuscles is found. Its pigmented stroma cells of the choroid manifest no material pathological change.

The retina is œdematous, particularly near the entrance of the optic nerve. Here, that condition described by various authors, and delineated by Pagenstecher, is found, viz., oval cavities in the granular layers filled with fine threads of fibrin, as we find them in cases of Bright's retinitis. The layer of nervous fibres shows the remains of numerous hemorrhages.

The entrance of the optic nerve is thickened, congested, and œdematous. The connective tissue of the optic nerve is hypertrophic at the expense of the nervous elements.

Anatomical Diagnosis.—Vulnus corneo-sclerale, with incarceration of the iris; cyclitis purulenta; hyperæmia of the choroid; detachment of the retina; retinitis and neuritis optici; aphakia.

24.

The following eye was enucleated by *Dr. E. Gruening*, for sympathetic irido-choroiditis.

The clinical record presents the following points of interest:

G. H., æt. 14, presented himself Sept. 4, 1874, stating that six weeks previously a stone had struck his right eye. *Present Condition*: *R.* A cicatrix, which encloses the iris, traverses the cornea. The ciliary region is very painful on pressure and spontaneously. *L.* Photophobia and lachrymation. The father of the boy would not consent to the enucleation of the right eye until the 11th of the same month. Then the left was found to be in a state of violent iritis, reduction of vision to $\frac{5}{200}$, great photophobia and lachrymation. The left eye improved somewhat after the enucleation, but soon grew worse again. Notwithstanding most careful treatment for months, a pupillary membrane was forming; and,

when the patient was discharged, he could again count fingers at five feet only. He returned in the fall of 1875 with complete occlusion of the pupil, but good perception of light. Dr. Knapp endeavored to make a central pupil, but found it impossible to accomplish any material result, on account of a complete degeneration of the tissue of the iris.

The globe is small. The cornea is flattened, and shows a large cicatrix. The iris is adherent to the scar, and is thickened. The lens seems to be absent. The vitreous chamber is filled with an exudation. The posterior part of the sclerotic is more than doubled in thickness.

The cornea is thinned; its epithelium, however, is thickened. The thinning of the cornea is produced by sclerosis of its parenchyma. The broad scar in its parenchyma is composed of spindle-shaped cells, between which pigment and and many vessels are found. Bowman's layer and Descemet's membrane are twisted.

Tissue of the iris is united to the cicatrix. Its normal structure is converted into a tissue, composed to a great extent of round cells, filling the anterior chamber, and containing many vessels and remains of pigment. The sphincter iridis can yet be recognized. The pupil is plugged with dense connective tissue, arranged in lamellæ, with many round cells and vessels. Where this papillary membrane is united to the iris, it assumes so much of its appearance that only the remnants of the sphincter can serve as a line of demarcation between them. The periphery of the posterior surface of the iris is attached to the ciliary body and covered with new-formed tissue, which is composed of spindle-shaped and round cells, and represents a cyclitic membrane, which involves the retinal part of the ciliary body. This tissue contains many hemorrhages, and the capsule of the lens, which is folded. The lens substance has undergone fatty degeneration.

The inner layers of the ciliary body are filled with round cells, while the outer layers are expanded by a serous exudation. Its muscle and vessels appear to be atrophied.

The ciliary nerves manifest nothing abnormal. One of them, however, is compressed in one place; yet its elements are unchanged.

The outer layers of the choroid are swollen by a serous exuda-

tion, containing a small number of round cells with which the capillary layer of the choroid is saturated. The vessels of the choroid are dilated. The pigment cells of the parenchyma and the epithelial layer are decaying.

The optic nerve is very hyperæmic. The lymph sheaths of its vessels are dilated. Its nervous fibres appear normal. The layer of nervous fibres of the retina is atrophied. Müller's supporting fibres are thickened. Many of the ganglionic cells are converted into hyaline vesicles (colloid).

The conjunctiva presents a rare condition. It is very hyperæmic, and partly infiltrated with blood. Furthermore, it contains large canals and cavities with serous contents, in which a small number of round cells are suspended. The walls of this system of canals are lined with a delicate endothelium. This condition is doubtless one of lymphangiectasia of the conjunctiva.

Anatomical Diagnosis.—Phthisis bulbi; lymphangiectasia conjunctivæ; irido-cyclitis purulenta et plastica; choroiditis serosa; atrophy of the retina; hyperæmia of the optic nerve.

25.

The following eye was enucleated by *Dr. Pooley*, at the Insane Asylum at Utica, for sympathetic irido-choroiditis.

The globe is abnormally small. The corneo-scleral margin presents a scar, which extends into the ciliary body. A section shows the anterior chamber to be very deep and filled with an exudation. The corneal and scleral lips of the wound are much thickened. At its posterior surface a stump of iris is found. (I afterwards learned that an iridectomy had been made.) Opposite to the scar the sclerotic is somewhat thinned and ectatic. Behind the iris there is a large lens-shaped formation, which seems to consist partly of blood and partly of chalk. The retina is detached. The sub-retinal space is filled with an exudation, which contains many crystals.

Microscopical Condition.—The cornea is generally thinned, but thickened at the scar, where round cells and pigment lie between its lamellæ.

A laminated tissue, composed of spindle-shaped cells, proceeds from the cicatrix to the central end of the opposite part of the iris, enclosing the thickened, club-like stump of iris; and these

parts form together the posterior boundary of the anterior chamber. At this side the insertion of the iris is attached to the cornea, and thus appears broader. The normal structure of its parenchyma is lost; its tissue represents a mere mass of round cells with some remains of pigment. At its posterior surface lies a thin membrane, formed of the ciliary part of the retina, in which the uveal pigment of the iris loses itself.

This cyclitic membrane has drawn the posterior parts of the ciliary body and the neighboring choroid and sclerotic inward. A sero-purulent exudation lies between the atrophic muscular fibres of the ciliary body.

A similar exudation fills the meshes of the choroid, which thus appears thickened. The posterior parts of the choroid are very hyperæmic. Its inner layers, near the entrance of the optic nerve, contain an osseous plate. The lamina vitrea cannot be found under the bone.

The ciliary nerves are entirely normal.

The retina is detached, enclosing some vitreus, and is entirely converted into connective tissue with some pigment.

The exudation, which separates the retina and choroid, is of a serous nature, and encloses numerous crystals of cholesterin.

The lens-shaped body, surrounded by the new-formed membrane, is, as was stated under the macroscopical investigation, composed of blood and chalk. Its lenticular shape and sharp contour might have misled to the diagnosis of a so-called hemorrhagic cataract. But it is clearly seen that the chalky mass only substitutes the lens, and is entirely surrounded by the capsule, while the hemorrhage bears no relation to it.

The optic nerve is atrophic, and has undergone connective-tissue degeneration.

Anatomical Diagnosis.—Phthisis bulbi; cicatrix resulting from iridectomy, with enclosure of the iris; iritis purulenta; cyclitis serosa et plastica; choroiditis serosa, and ossification of the choroid; detachment of the ciliary body and choroid; atrophy and detachment of the retina; atrophy of the optic nerve; cataracta calcarea.

All of the following globes were received from *Drs. E. Wil-*

liams and *Ayres*, and were enucleated for pronounced sympathetic irido-choroiditis. The clinical history of four of these cases has been published by *Dr. Ayres* in these Archives, Vol. V., pp. 227–229.

26.

T. H., æt. 5.—When I received the globe, it had been opened, but appears to have been of normal size. Perhaps the cornea is somewhat flattened. The corneo-scleral margin has a scar. The iris is attached to the whole inner surface of the cornea. The iris, ciliary body, and choroid are considerably thickened. The lens appears normal, and is crowded against the iris by a cyclitic membrane. The optic nerve is attenuated. The adjacent part of the retina is thickened; the other parts are detached. It is questionable whether this was the case during life.

The following are the microscopical conditions: Some iris and Descemet's membrane lie in the corneal cicatrix. The tissue of the iris and ciliary body is converted into a continuous uniform mass of round cells. The uveal pigment of the iris is loosened and scattered about. The pigment cells of the parenchyma have entirely disappeared, and the tissue thus changed has no trace of vessels. That part of the mass of round cells, which corresponds to the ciliary body, presents minute muscular fibres at its outer part. It evidently took an active part in the production of the round cells. Some of these muscular fibres contain two or three nuclei, and the surrounding protoplasm is scant. The same applies to the muscular coat of the vessels, which are reduced in number.

The cyclitic membrane, in the formation of which the proliferating retinal layer of the ciliary body actively participated, presents but few round cells, vessels, and fresh hemorrhages.

The choroid—thickened some three or four times its natural diameter—consists almost exclusively of round cells. The pigment epithelium appears unchanged. The ciliary nerves appear unchanged.

The anterior capsule of the lens is attached to the iris and its posterior capsule to the cyclitic membrane. A part of the lens is absent; the remainder is partially normal, partially undergoing fatty degeneration.

The whole retina is infiltrated with round cells.

The substance of the optic nerve is full of round cells, which adhere particularly to its trabeculæ of connective tissue. Its vessels are hyperæmic.

Anatomical Diagnosis.—Vulnus corneo-sclerale, with imprisonment of the iris; purulent inflammation of the entire uveal tract; complete anterior synechia; cataracta traumatica; neuritis optici.

27.

H. H.—The globe is reduced in size from corneal flattening. A scar passes from one corneal margin to the other. Section reveals a dense band of new-formed tissue proceeding from the cicatrix behind the iris, which is connected with it, there to unite with a thick cyclitic membrane, which seems to enclose remains of the lens. At the juncture of the cicatricial tissue with the cyclitic membrane a large piece of a percussion-cap is found. Thence a tough band of tissue traverses the vitreous chamber, and draws the ciliary body, which is nearly doubled in breadth, forward and inward. The retina is entirely detached.

The following are the microscopical conditions: The cornea is much thinned and strongly vascularized; the lips of the wound are thickened, without, however, being filled with an unusual amount of cells. The epithelium over the scar is much thickened, and sends conical projections into the canal of the wound. The endothelium of Descemet's membrane is in a process of proliferation. The remainder of the anterior chamber encloses pus and detritus.

The cicatricial tissue which traverses the cornea presents the conditions before described. It is pigmented and vascularized. The iris is attached to it, and converted into a very broad mass composed of round cells, remains of pigment, and hemorrhages. It presents no remains of muscular tissue and but few vessels. Behind it lies also a new-formed tissue, in the formation of which the cicatricial tissue and a cyclitic membrane participate; the foreign body lies imbedded in dense layers of this new tissue, which also encloses the capsule of the lens, which is plicated and still contains remains of the lens. From it a band of tough connective tissue, enclosing vessels and fresh hemorrhages, extends backward to the sclerotic.

The course and arrangement of the fibres of the ciliary body

have been completely changed by the traction, and, furthermore, they are saturated with round cells. The muscular tissue of the ciliary body is atrophic, and its vessels are much reduced in number.

The choroid is much thickened, and has entirely lost its normal structure. It consists of round cells, among which are remains of the choroidal pigment and a few engorged vessels. The pigment epithelium is unchanged. Furthermore, in the ciliary region the sclerotic is transformed into cavernous tissue.

The ciliary nerves present no alteration. All the layers of the detached retina are filled with round cells, but still separately recognizable. Near the entrance of the optic nerve, remains of old hemorrhages are found. The place where the retina was pierced by the foreign body could not be found.

The optic nerve is saturated with round cells. The lamina cribrosa and the longitudinal trabeculæ of connective tissue are much thickened; some nervous fibres have undergone fatty degeneration.

Anatomical Diagnosis.—Vulnus corneæ; phthisis anterior; corpus alienum in bulbo; atrophy of the ciliary body after cyclitis plastica; recent purulent inflammation of the entire uveal tract and of the detached retina; neuritis optici; cataracta traumatica.

28.

F. W. R.—The globe is reduced in size by almost complete flattening of the cornea to which the iris and ciliary body are united. Both are drawn forward; a cyclitic membrane lies directly behind the iris; the sclerotic is somewhat, the optic papilla and its surroundings are much thickened.

Microscopical Examination.—The epithelium of the cornea is thickened. In the cicatrix the epithelium penetrates, through Bowman's layer which is ruptured, into the corneal parenchyma. The corneal parenchyma manifests a considerable cell-proliferation, and is traversed by a number of vessels around the scar. Descemet's membrane is detached and folded. Its endothelium is proliferating. The cicatricial tissue is composed as usual of long, spindle-shaped cells, which enclose vessels, pigment, and round cells, and connects with the iris.

The iris and ciliary body have lost their normal structure, being converted into a very vascular tissue containing many round and a few pigment cells. The sphincter of the iris has disappeared, and the muscular fibres of the ciliary body are atrophied.

In the supra-choroidal cavity is some sero-purulent exudation. The choroid is infiltrated with round cells. Its periphery presents a number of cavities, as are frequently found at the ora serrata in the retina. They vary in size, and have separate walls lined with endothelium. Thus they appear as cysts of the choroid; they may be, perhaps, varicose vessels only, with atrophic walls.

The changes in the retina correspond to those which are found in morbus Brightii. All its layers are œdematous and enlarged. The radial fibres are strongly marked. The intergranular layer seems to be the most enlarged. The layer of nerve fibres contains many round cells, and the inner- and intergranular layers show many small cavities filled with threads of fibrin. Furthermore, hemorrhagic spots are found.

The entrance of the optic nerve is also œdematous. The lamina cribrosa and the longitudinal trabeculæ of connective tissue of the optic nerve are strongly marked, and surrounded by round cells. The ciliary arteries, which enter through the sclerotic in the vicinity of the optic nerve, are surrounded by round cells. The ciliary nerves are unchanged.

Anatomical Diagnosis.—Vulnus corneo-sclerale; phthisis anterior; cyclitis plastica et purulenta; iritis and choroiditis purulenta; retinitis; neuritis optici; cataracta traumatica; formation of cysts in the choroid (?).

29.

W. M.—The globe is phthisical. The posterior section of the sclerotic is considerably thickened. The cornea presents a marginal scar, behind which a part of the iris is absent. Cicatricial tissue behind the corneal scar envelops the iris, and unites with a cyclitic membrane and the detached retina. The choroid is thickened.

The corneal scar is very broad and deeply pigmented. It is of the usual structure. It proceeds from the cornea to the ciliary body (the iris is wanting here) and to the opposite part of the

iris. Behind it granulation tissue projects from the ciliary processes. It is composed almost solely of round cells and threads of fibrin, among which the uveal pigment of the iris and ciliary body is scattered. This tissue contains minute remains of the lens substance, enveloped by the folded capsule. The tissue of the iris is much thickened, very little pigmented, and filled with round cells. Its vessels are engorged.

The ciliary body is also filled with round cells, leaving its muscular tissue barely discernible. Its vessels, reduced in number, are increased in calibre. At some places the round cells are crowded together in the form of little abscesses. The pars ciliaris retinæ is enlarged. That part of the periphery of the retina which lies upon it, as well as the entire band which goes to the optic nerve, has lost its normal structure, and is converted into connective tissue, full of round cells.

The tissue of the choroid consists merely of round cells and vessels. The pigmented stroma cells have disappeared. The cells of the pigment epithelium are disorganized. The vessels are dilated. The ciliary nerves are normal.

The lamina cribrosa and the perineurium internum are somewhat thickened, and interspersed with many round cells.

Anatomical Diagnosis.—Phthisis bulbi; vulnus corneo-sclerale; cyclitis plastica et purulenta; iritis et choroiditis purulenta; detachment and atrophy of the retina; neuritis optici; cataracta traumatica.

30.

Mrs. Br.—The globe is small and oval. A broad cicatrix is at the corneo-scleral margin, and another not far from the first, in the ciliary region. The iris and ciliary body are thickened and drawn into the cicatrices. A dense, new-formed tissue, containing particles of lens matter, but no retinal tissue, lies within the pupil, and fills the entire vitreous space. The choroid and retina are thickened, mostly around the entrance of the optic nerve.

The two cicatrices present no histological change. The corneal tissue is otherwise normal. The endothelium of Descemet's membrane is thickened in several places. The ligamentum pectina-

tum and the entire tissue which enters into the formation of the angle of the iris, are saturated with round cells.

The iris is densely filled with round cells, by which its normal thickness is increased three or four times.

The ciliary body and choroid are converted into a dense accumulation of round cells, presenting no trace of muscular tissue. The pigmented stroma cells of the entire uveal tract are destroyed. The ciliary nerves are unchanged. The tissue which fills the vitreous chamber is essentially composed of round, spindle-shaped cells, and fibrous strips, and many vessels. Several of these strips are doubtless degenerated retina.

The supra-choroidal cavity is obliterated. The inner layers of the sclerotic are densely infiltrated with round cells.

The optic nerve is attenuated. Its connective tissue hypertrophied, and its nervous fibres are reduced in number.

Anatomical Diagnosis.—Vulnus corneo-sclerale, with incarceration of the iris and ciliary body; irido-choroiditis purulenta et plastica; detachment and complete degeneration of the retina; atrophy of the optic nerve; cataracta traumatica.

31.

The following eye was enucleated by *Dr. Mooren*, because of sympathetic irido-choroiditis, and has already been described by me, in my "Contributions to the Path. Anat. of the Eye," under "A Case of Sub-conjunctival Dislocation of the Lens." The following is an extract therefrom:

A large cicatrix, enclosing ciliary, body, and remains of the iris, occupies the corneo-scleral region; a cyclitic membrane, proceeding from the scar, traverses the globe, and by its contraction has detached the ciliary body from the sclerotic. The iris and ciliary body are filled with round cells. Near the wound the choroid is likewise detached and saturated with round cells. The retina is detached, and has undergone connective-tissue degeneration; all the cavities of the eye are filled with a purulent and hemorrhagic exudation; under the conjunctiva and upon the cicatrix the somewhat cataractous lens is found.

The ciliary nerves are normal.

Anatomical Diagnosis.—Vulnus corneo-sclerale, with incarceration of iris and ciliary body; luxatio lentis subconjunc-

tivam; detachment of the ciliary body and choroid following plastic cyclitis; irido-choroiditis purulenta; atrophy and detachment of the retina.

The literature presents the following twenty-one cases, "enucleated for sympathetic irido-choroiditis."

(This series also includes such eyes as were briefly designated "enucleated for sympathetic *ophthalmia*.")

Graefe's Archives.

III., 2, p. 442, etc., *von Graefe.*—The cornea presents a large scar. The choroid and ciliary body are in a state of purulent inflammation. The lens is calcified, and the retina is detached.

XII., 2, *v. Graefe.*—A corneo-scleral scar encloses prolapsed ciliary body. Cyclitis plastica.

XV., 2, p. 9. *Iwanoff.*—From a corneal scar a band unites with a tough membrane, occluding the pupil. Iris drawn towards the scar. Purulent choroiditis.

Klinische Monatsblätter.

1864, p. 223. *H. Müller.*—Corneal scar enclosing the iris. Two large cysts between sclerotic and choroid.

1865, p. 3. *C. Pagenstecher.*—Seven months previous to the enucleation the eye suffered a contusion, which caused an almost complete detachment of the lens from the Zonula Zinnii. The iris is sunken and attached to the ciliary body by plastic exudation. The lens is cataractous. The entrance of the optic nerve is deeply excavated.

1871, p. 262. *Höring.*—About two months elapsed between the time of injury and enucleation. The corneo-scleral region shows a contracted cicatrix. The iris is attached to the cornea, and the lens to the posterior surface of the iris. A splinter of granite is found in the ciliary body, surrounded by pus and new connective tissue.

1872, p. 253. *Just.*—The iris is imprisoned in a corneal scar. Choroid and retina detached. The entire uveal tract shows purulent infiltration.

1873, p. 123. *Pagenstecher, Herm.*—A cicatrix is found in the corneo-scleral region. The iris is covered with a new-formed tissue, occluding the pupil. The retraction of a cyclitic membrane has detached the ciliary body. The entire uveal tract is thickened and in a state of purulent inflammation. The retina is detached.

Ophthalmic Hospital Report.

II. p. 11. *Bader.*—The eye was enucleated six weeks subsequent to an injury at the upper and outer ciliary region. The anterior part of the globe is entirely filled with new-formed tissue. The vitreus is flocculent. A little turbid fluid lies between retina and choroid. Retraction of the cyclitic membrane has drawn the ora serrata retinæ inward. The retina itself is hyperæmic and slightly opaque. The choroid is infiltrated with pus, especially in the region of the optic nerve and macula lutea.

V. 1. *Lawson, Geo.*—The globe was injured by a gun-cap, and enucleated seven years later. The globe is entirely atrophied, and contains the foreign body.

Klinische Beobachtungen aus der Augenheilanstalt zu Wiesbaden, 1862.

Hofr. Pagenstecher, M.D.—"Enucleatio-bulbi," etc.

Dr A. Pagenstecher.—Autopsies.

Page 51, 1. (*Autopsy I.*).—Globe enucleated three months subsequent to injury. In the uveal tract purulent infiltration. Cornea converted into connective tissue. There is cellular infiltration along the vascular and nervous canals in the sclerotic.

7. *H. Müller.*—It was alleged that the eye suffered from an idiopathic inflammation three to four months before the enucleation. The retina is detached, thickened, and pushed forward. The thickening is the result of a conversion of the retinal elements into a tissue composed of spindle-shaped cells. The choroid shows a similar change. A fibrinous substance lies between retina and choroid, in the anterior and vitreous chambers, and between the folds of the retina. The lens is attached to the iris, the periphery of which is crowded forward by a fibrinous substance.

11. (*Autopsy X.*).—Patient suffered from an inflammation of

the eye five years previous to the enucleation. The anterior chamber is filled with blood, pus, and fibrin. The iris is attached to the cornea and lens by means of new-formed irido-cyclitic membranes, which entirely envelop the cataractous lens. The retina is detached and completely atrophic. The choroid is thickened everywhere, and filled with puriform elements. It contains a swelling the size of a hazel-nut, essentialy composed of round and spindle cells; its centre is decaying. (Sarcoma?) In the neighborhood of the swelling the sclerotic is hyperæmic and pigmented.

Utrecht Annual Report, 1865.

Page 58. *Maats, J. J. I.*—A cicatrix is found in the sclerotic, which encloses iris, ciliary body, choroid, and the capsule of the lens. A large ciliary nerve enters it. The opposite part of the ciliary body is hypertrophied. The choroid is much thickened and united to the sclerotic. The vitreus presents old hemorrhages, detritus, and cells. The retina is not discoverable.

Ibid. 2. The sclerotic presents a scar in front of the ciliary muscle, enclosing the iris, and covered with a new-formed tissue. A large ciliary nerve enters the cicatricial tissue. The remainder of the iris is attached to the cornea. The vitreus is shrunken.

Annales d' Oculistique.

1876, Jan. and Feb., p. 27. *Savary.*—Five months previous to the enucleation the eye was injured. A stone is found in the globe. The cornea is thickened at the cicatrix. The cataractous lens is attached to the corneal wound. The choroid and retina are drawn into a scleral scar. The retina is partly detached.

Archives of Ophthalmology and Otology.

II. 1. *Knapp, H.*—Irido-choroiditis chronica with ossification of the choroid. The retina is detached. The lens is calcified, and behind it a cyclitic membrane is found. The ciliary nerves are intact.

Ibid.—The eye had suffered a contusion five years previous to the enucleation. Old choroiditis with ossification is found. Furthermore, there is a recent irido-cyclitis with the formation

of a cyclitic membrane. The retina is detached; ciliary nerves normal.

Ibid.—Plastic irido-cyclitis; choroid ossified; retina detached.

Injuries of the Eye, Orbit, and Eyelids. By Geo. Lawson, 1867.

Page 214. CASE LXXIII.—The enucleation was made fourteen years subsequent to a traumatism. A piece of a percussion-cap, surrounded by new-formed connective tissue, lies upon the ciliary body. The retina is detached.

Atlas d. path. Anat. d. Augapfels. By H. Pagenstecher and C. Genth.

Pl. 38. fig. 12.—The eye had been injured twenty-seven years previous to the enucleation. The cornea presents a scar, which encloses the iris. The iris and ciliary body are thickened. The latter contains a foreign body. Sympathetic irido-choroiditis manifested itself six days subsequent to the enucleation.

V.

GLOBES ENUCLEATED FOR SYMPATHETIC AFFECTION OF THE RETINA.

32.

The following globe was enucleated by *Dr. Gruening*, for sympathetic neuro-retinitis. The clinical history of the case presents the following points of interest.

J. D., æt. 35, lost his left eye, some fourteen years ago, by a suppurative affection of the cornea, and wore an artificial eye upon the phthisical globe. Three weeks ago vision in the right began to diminish and an ophthalmoscopic examination showed the conditions of neuro-retinitis, ex morbo Brightii. The patient could count in the nasal half of F. fingers immediately before the eye, while in the other half he had no perception of light.

When he presented himself again sympathetic irido-choroiditis was

manifest. The left globe was then enucleated. Notwithstanding all therapeutic efforts, under alternating aggravations and improvements, the eye was finally lost. $+T_2$.

The size of the globe is diminished by flattening of the cornea. The cornea is thinned and the whole iris adherent to its posterior surface. The ciliary body and neighboring parts of the choroid appear enlarged. A thin cyclitic membrane lies upon the posterior surface of the iris and upon the anterior part of the detached retina. The optic nerve is attenuated; the sclerotic is somewhat thickened; the space between retina and choroid is filled with exudation.

Microscopical Examination.—The epithelial coat of the cornea is very thin, and sends some conical prolongations into the centre of the corneal substance. Bowman's membrane cannot be differentiated. The iris is atrophied.

The ciliary body is drawn forward and so much inward, that the ciliary processes almost touch one another. This condition is produced by the retraction of the above-mentioned cyclitic membrane. The muscular fibres of the ciliary body are atrophied; the ciliary nerves manifest no pathological changes.

The choroid is atrophic and œdematous. Numerous colloid excrescences lie upon the hyaline membrane.

The folds of the capsule of the lens enclose disintegrated lens fibres and free pigment.

Branched figures of pigment occupy the inner retinal layers, and follow the course of the vessels, some of which enter into the ciliary body; the retina and optic nerve are completely converted into connective tissue.

Anatomical Diagnosis.—Cornea converted into cicatricial tissue; complete anterior synechia and atrophy of the iris; atrophy of the ciliary body, the result of cyclitis plastica; choroiditis serosa; colloid excrescences of the choroid; retinitis pigmentosa; detachment and atrophy of the retina; atrophy of the optic nerve.

The following four cases, recorded in literature, were enucleated for sympathetic neuro-retinitis.

Graefe's Archives.

XII., 2, *v. Graefe.*—A calcareous cataract, dislocated into the

anterior chamber, had been extracted. Plastic irido-cyclitis and choroiditis.

Ibid.—Chronic choroiditis with chalky deposits on the inner surface of the choroid. Retina detached.

Archives of Ophthalmology and Otology.

II. 1, p. 284. *Pooley, T. R.*—The eye was injured four weeks previous to the enucleation. A corneo-scleral scar encloses iris and ciliary body; purulent inflammation in the entire uveal tract; the ciliary nerves are normal.

Ibid.—The traumatism occurred forty years previous to the enucleation. Repeated inflammations produced staphyloma, finally rupture, and consequent atrophy of the globe. The iris and ciliary body are recognizable only by their pigment. The choroid is partly atrophied, partly affected with suppurative inflammation. Cyclitic membrane; retina detached and atrophic.

VI.

The two following globes, as reported in literature, were enucleated for

SYMPATHETIC AFFECTION OF THE CORNEA.

Utrecht Annual Report, 1865.

Page 58. *Maats I. I.*, 3.—Ten months subsequent to an injury of one eye, sympathetic irritation of the other occurred, two phlyctenæ appearing at the upper corneal margin, "as in scrofulous ophthalmia." The retina is detached in stripes; its periphery lies behind the lens. The ciliary muscle is swollen; pseudo-membranes lie upon the choroid; the ciliary nerves manifest fatty degeneration.

Klinische Beobachtungen aus der Augenheilanstalt zu Wiesbaden, 1862.

AUTOPSY VI., *A. Pagenstecher.*—Clinical diagnosis: staphyloma corneæ, following acute granulations; staphyloma removed,

with partial removal of the lens; pain and conjunctival injection remaining. Enucleation made, while there was still quantitative perception of light, on account of obstinate superficial keratitis, attributed to sympathetic influences. The cornea is substituted by a staphylomatous cicatricial tissue. The pupil is closed by a dense membrane, which draws the few remains of the lens and the ciliary body towards the staphyloma. The choroid and retina are normal.

STATISTICS OF 110 CASES.

TABLE I.

I. *Eyes enucleated for sympathetic irritation.*

Number and name of the author.	*Cornea.*	*Sclerotic.*	*Corneo-scleral margin.*	*Ciliary body.*	*Iris.*	*Lens and vitreous body.*	*Choroid.*	*Retina.*	*Optic nerve.*	*Ciliary nerves.*
A. Alt. 1.		Scar in the lower half.		Purulent cyclitis.	Purulent iritis.	Hemorrhages and fibrinous masses in the vitreous body.	Chorioiditis in the region of the scar. Hyperæmia.	Degenerated into connective tissue in the cicatricial region. Infiltrated with round cells in its peripheric portions.	Intra-ocular granuloma of the optic nerve. Atrophy.	Normal. One lies in the tissue of the scar.
2.		A staphylomatous scar.		Detachment produced by hemorrhage. Hyperæmia.	Hyperæmia.	Soft cataract.	Detachment produced by hemorrhage. Hyperæmia.	Atrophy. Hemorrhages.	Excavation. Atrophy.	Normal.
3.	Proliferation of the endothelium.			Cyclitis. Hemorrhages.	Purulent iritis.		Plastic choroiditis.	Fibrinous exudation lying upon the yellow spot.		Normal.
4.				Atrophy after plastic cyclitis.	Periphery adherent to cornea and infiltrated with round-cells. Pupillary edge atrophic. Vitreous membrane.	Chalky cataract, dislocated down- and backward.	Serous and plastic choroiditis. Ossification.	Detachment and degeneration into connective tissue.	Atrophy.	Normal.
5.			Scar with incarceration of iris and ciliary body.	Plastic cyclitis. Filled with sero-purulent exudation.	Purulent iritis.		Serous choroiditis.			Normal.
6.	Scar and purulent keratitis			Purulent cyclitis.	Purulent iritis.	Purulent hyalitis.	Purulent choroiditis.	Detachment. Atrophy.	Atrophy.	Normal.
7.	Flat. Scar.	Scar.	Scar.	Scar, drawn inward by cyclitic membrane and filled with sero-purulent exudation.	Purulent iritis.	Cataract.	Sero-purulent choroiditis.	Detachment. Œdema.		One compressed at two places. Otherwise normal.
8.			Scar.	Plastic cyclitis. Drawn forward.	Torn in one place. Occlusion of pupil.	Cataract.	Venous hyperæmia.	Atrophy.	Neuritis optici.	Normal.

" 9.			Scar, in which ciliary body and retina are embedded.	Detached. Old hemorrhages. Plastic cyclitis.	Atrophy.	Small cataractous remnants.	Venous hyperæmia.	Detachment. Atrophy and pigmentation.		Normal.
10.	Indrawn scar with incarceration of iris.			Drawn forward. Plastic cyclitis.	Purulent iritis.	Cataract.	Venous hyperæmia.	Detachment. Œdema of yellow spot. Otherwise atrophy.	Excavation. Atrophy.	Normal.
11.			Indrawn scar with incarceration of iris after extraction of cataract.	Purulent cyclitis.		Purulent hyalitis.	Detachment. Purulent choroiditis.	Atrophy.	Œdematous.	Normal.
12.	Scar in which iris is embedded.				Atrophy.	Cataract.	Atrophic choroiditis. Sclerochoroiditis posterior.	Partially detached. Atrophic patches.	Excavation.	Normal.
13.	Two scars in which iris is embedded.			Cyclitis.	Atrophy after plastic iritis. Occlusion of pupil.		Choroiditis. Hemorrhages. Colloid excrescences with chalky deposits.	Partially detached. Some atrophy.	Excavation.	Normal.
14.				Plastic cyclitis.	Contracted. Anæmic.	Dislocated backwards. Intraocular hemorrhage.	Serous choroiditis.	Detachment. Atrophy.		
15.	Scar.		Scar in which a foreign body is embedded.	Cyclitis.	Iritis.	Cataract.	Old chorioiditis, with atrophy. New choroiditis.	Old Retinitis. Atrophy.	Atrophy.	Normal.
H. Müller.		Sclerectasia.		Cyclitis.	Iritis.	Capsular cataract.	Choroiditis.	Detachment.		Atrophic.
Iwanoff.							Purulent choroiditis.			
Iwanoff.						Vitreous chamber filled with blood.	Hypertrophy of connective tissue.			Thickened neuroglia. Round-cell infiltration.
"				Detached. Plastic cyclitis.		Depressed cataract adherent to the ciliary body.	Detached.			
"			Scar after extraction of cataract.	Sero-purulent cyclitis.	Sero-purulent iritis.	Hyalitis.	Sero-purulent choroiditis.			
Brecht.			Scar.	Plastic cyclitis.	Plastic iritis.		Detached.	Detached.		
Geo. Lawson.	Scar.				Iridodialysis.	Dislocation into the vitreus.	Detached.	Detached.		

TABLE I. Continued.

I. *Eyes enucleated for sympathetic irritation.*

Number and name of the author.	*Cornea.*	*Sclerotic.*	*Corneo-scleral margin.*	*Ciliary body.*	*Iris.*	*Lens and vitreous body.*	*Choroid.*	*Retina.*	*Optic nerve.*	*Ciliary nerves.*
Geo. Lawson.		Scar in ciliary region, embedding ciliary body and choroid.		Foreign body in ciliary body. Purulent cyclitis.				Detached.		
Vernon.		Scar in ciliary region.		Scar. Plastic cyclitis.	Lens wanting.		Detached.			Some lie in the cicatricial tissue.
"		Scar near the entrance of the optic nerve.	Scar after extraction of cataract.			Scar in iris.	Scar-tissue passing through the vitreous body.		Partially detached.	Foreign body lying on the extra-ocular part of the optic nerve.
"		Two scars, in one of which the iris is embedded.		Plastic cyclitis.	Plastic iritis.			Detached.		
"		Indrawn scar in the ciliary region.		Plastic cyclitis.				Detached.		
"	Scar in the total anterior part of the globe.					Lens and vitreus wanting.		Detached.		
"		Scar.	Scar in which choroid and retina are embedded.			Lens wanting.		Detached.		
Brayley.			Scar with incarceration of iris.	Foreign body in ciliary body. Cyclitis.		Cataract.		Œdema.		
Hofr. Pagenstecher.	Scar.			Purulent cyclitis.	Purulent iritis.	Lens wanting. Vitreous chamber filled with new-formed connective tissue with foreign body in it.	Choroiditis plastica.	Detached.		
A. Pagenstecher.	Scar in which iris is embedded.						Colloid excrescences. Ossification.	Detached.		

A. Pagenstecher.	Old scar. New keratitis				Atrophy.		Ossification.	Detached.		
"	Scar.				Iritis. Anterior synechia.	Lens shrunken. Foreign body in vitreo. Purulent hyalitis.		Detached.		
"				Powder grains in ciliary body. Purulent and plastic cyclitis.	Purulent iritis.	Purulent hyalitis.	Purulent choroiditis.			Normal.
I. I. Maats.				Plastic cyclitis.	Plastic iritis.		Atrophic patches.	Detachment and pigmentation.	Excavation.	
"					Iris wanting.	Lens wanting. chalky deposits in vitreo.				
"	Keratitis.		Scar after iridectomy.	Atrophy.	Partially iritis, partially atrophy.			Atrophy.	Excavation.	
"		Staphyloma.			Atrophy.	Small remnants of cataract.	Detached around the disc. Otherwise firmly attached to sclerotic.	Detached.		
"	Scar in which iris is embedded.			Purulent cyclitis.	Iritis. Anterior synechia.	Cataract. Purulent hyalitis.	Foreign body in choroid.	Detached.		
"			Scar after extraction of cataract with incarceration of iris.	Cyclitis plastica. Chalky deposits.				Detached.		
"				Plastic and purulent cyclitis.	Purulent iritis.	Foreign body in vitreo. Purulent hyalitis.		Detachment. Atrophy.		
Schiess-Gemuseus.				Plastic cyclitis. Foreign body in cyclitic membrane.		Shrunken cataract.	Ossification.	Detachment.		Chalky deposits in the neurilemma.
Iwanoff.				Plastic and purulent cyclitis. (Specific?)	Iritis gummosa.	Cataract.	Hyperæmia.	Œdema.		Schwann's sheath thickened. Number of nuclei increased.
"	Scar with incarceration of iris.	Scleritis and episcleritis.		Detached cyclitis plastica. New cyclitis. Cysts between ciliary body and cyclitic membrane.	Iritis. Anterior synechia.	Cataract. Hyalitis.	Detached.	Atrophy. Round-cell infiltration in the periphery.		

TABLE I. Continued.

I. *Eyes enucleated for sympathetic irritation.*

Number and name of the author.	*Cornea.*	*Sclerotic.*	*Corneo-scleral margin.*	*Ciliary body.*	*Iris.*	*Lens and vitreous body.*	*Choroid.*	*Retina.*	*Optic nerve.*	*Ciliary nerves.*
Iwanoff.			Scar after extraction of cataract in which Iris and lens-capsule are lying.	Plastic cyclitis. Part opposite the scar detached.		Vitreous chamber filled with exudation.				
Aug. Prichard	Scar.		Lens-capsule lying on the ciliary body.			Lens-substance absorbed.	Detached by fibrinous exudation.			One much torn.
Bader.					Vessels of iris are varicose. Plastic iritis.	Cataract.		Detachment.		
H. Knapp.	Scar.			Scar. Plastic cyclitis.	Scar. Plastic iritis.	Cataract.	Ossification.	Detachment.		
Leber.	Scar.		Foreign body upon the normal ciliary body.			Purulent circumscribed hyalitis.			Increase of connective tissue.	
Waldeyer.							Chronic choroiditis. Atrophy.	Fibrous exudation on retina.		
"								Hemorrhage and formation of folds at the macula lutea.		
Lawson.		Scar in ciliary region in which ciliary body and choroid are imbedded.		Foreign body. Purulent cyclitis.		Cataract.		Detachment.		
"		Scar in ciliary region.			Iris wanting.	Lens wanting. Vitreous chamber filled with blood.	Detached.	Detached.		
"	Scar.						Ossification.	Detachment.		
"	Scar with chalky deposits.						Ossification.	Detachment.		

II. *Eyes enucleated for sympathetic iritis.*

A Alt. 16.	Scar.			Plastic and serous cyclitis.	Purulent iritis. Anterior synechia.		Hypertrophy after choroiditis.	Detached.	Atrophy.	Not discoverable.
17.	Scar.			Atrophy after cyclitis.	Plastic iritis.		Atrophy. Colloid metamorphosis of the pigment-epithelium. Colloid excrescences.	Detachment. Atrophy. Pigmentation and ossification.	Atrophy.	Normal.
18.		Scleritis.	Scar to which iris, ciliary body and lens are adherent.	Plastic cyclitis.	Partial atrophy. Partial purulent iritis.	Cataract.	Purulent choroiditis.	Detachment. Œdema.	Atrophy.	Normal.
19.	Scar with incarceration of iris.			Atrophy.	Hemorrhages (hemorrhagic iritis). Atrophy.	Lens wanting.	Partial atrophy. Partial hyperæmia.	Detachment. Atrophy.		Normal.
20.	Scar.			Drawn forwards. Purulent cyclitis.	Purulent iritis. Anterior synechia.	Chalky cataract.	Purulent choroiditis. Large number of colloid excrescences.	Detachment. Atrophy. Chalky deposits.	Atrophy.	Normal.
21.			Indrawn scar with adhesion of iris.	Plastic and purulent cyclitis detached. Opposite to the scar.	Purulent iritis.		Purulent choroiditis.	Retinitis. Partial atrophy.	Neuritis. Proliferation of connective tissue.	Normal.
H. Müller.	Scar.			Plastic cyclitis.	Plastic iritis.		Choroiditis.		Fatty degeneration.	
Schweigger.	Scar.					Foreign body in lens. Cataracta intumescens.	Chronic choroiditis.			
"			Scar after iridectomy with incarceration of iris.	Purulent cyclitis.	Purulent iritis.					
Hirschberg.	Scar with incarceration of iris.			Plastic cyclitis.			Detached.			Normal.
Vernon.		Scar in the ciliary region with adhesion of iris.		Scar.	Plastic iritis.	Lens wanting.				

TABLE I. Continued.

II. *Eyes enucleated for sympathetic iritis.*

Number and name of the author.	*Cornea.*	*Sclerotic.*	*Corneo-scleral margin.*	*Ciliary body.*	*Iris.*	*Lens and vitreous body.*	*Choroid.*	*Retina.*	*Optic nerve.*	*Ciliary nerves.*
A. Pagenstecher.				Plastic cyclitis.	Plastic iritis. Ossification of pupillary membrane.		Serous and plastic choroiditis.	Detached.		
Hofr. Pagenstecher.						Lens depressed.	Lens adherent to choroid.	Detached.		
Iwanoff.	Scar with adhesion of vitreus, lens-capsule and iris.		Scar after iridectomy.	Detached. Cyclitis. At one place where a foreign body lies upon it, atrophy.	Purulent iritis.		Detached.			Nerves making part of the scar-tissue. Schwann's sheath thickened.
Handy.	Scar.			Plastic cyclitis. Foreign body in the cyclitic membrane.		Old hemorrhage in vitreo. Lens shrunken, adherent to cornea.		Detached.		

III. *Eyes enucleated for sympathetic irido-cyclitis.*

A. Alt. 22.	Indrawn scar			Atrophy after plastic cyclitis. Detached.	Iris wanting.	Lens wanting.	Detached. Chronic hyperæmia.	Detached around the disc. Atrophy.	Atrophy.	Normal.
Berlin.			Scar from iridectomy.				Melanosarcoma of choroid.		Excavation.	
I. I. Maats.	Scar.					Purulent hyalitis.		Detachment.		
Geo. Lawson.	Scar with prolapse of iris.					Fibrinous exudation in vitreous chamber.	Sero-purulent choroiditis.	Œdema. Proliferation of connective tissue.		

IV. *Eyes enucleated for sympathetic irido-choroiditis.*

A. Alt. 23.			Scar with incarceration of iris.	Purulent cyclitis.	Purulent iritis.	Lens wanting.	Hyperæmia.	Partial detachment. Retinitis.	Neuritis optica.	Some fatty degeneration.
24.	Scar with adhesion of iris.			Plastic and purulent cyclitis.	Plastic and purulent iritis.	Traumatic cataract.	Serous choroiditis.	Atrophy.	Hyperæmia.	Normal. One is compressed.

										Normal.

25.			Scar after iridectomy. Adhesion of iris.	Plastic and serous cyclitis. Opposite to the scar detached.	Purulent iritis.	Chalky cataract.	Detached. Ossification.	Detachment.		Normal.
26.			Scar with incarceration of iris.	Purulent cyclitis.	Purulent iritis. Anterior synechia.	Cataract.	Purulent choroiditis.	Purulent retinitis.	Neuritis optica.	Normal.
27.	Scar.			Old plastic cyclitis. New purulent cyclitis.	Purulent iritis.	Cataract.	Purulent choroiditis.	Detachment. Purulent retinitis.	Neuritis optica.	Normal.
28.			Scar with adhesion of iris.	Drawn forward. Plastic and purulent cyclitis.	Purulent iritis.	Lens absorbed.	Purulent choroiditis. Cysts.	Retinitis. Œdema.	Optic neuritis.	Normal.
29.			Scar.	Plastic and purulent cyclitis.	Purulent iritis.	Cataract.	Purulent choroiditis.	Detachment. Atrophy.	Atrophy.	Normal.
30.		Scar in ciliary region. Scleritis.	Scar.	Plastic and purulent cyclitis.	Plastic and purulent iritis.	Purulent hyalitis, mere remnants of the lens.	Plastic and purulent choroiditis.	Detached. Atrophy.	Atrophy.	Normal.
31.			Scar in which iris and ciliary body are embedded.	Plastic and purulent cyclitis. Opposite to the scar detached.	Purulent iritis.	Lens dislocated under the conjunctiva.	Detached. Purulent choroiditis.	Detachment. Atrophy.		Normal.
V. Graefe.	Scar.			Purulent cyclitis.		Chalky cataract.	Purulent choroiditis.	Detachment.	Chalky deposits in optic nerve.	
"			Scar in which ciliary body is embedded.	Torn. Plastic cyclitis.						
Iwanoff.	Scar.				Plastic iritis.		Purulent choroiditis.			
H. Müller.	Scar with incarceration of iris.						Two large cysts between choroid and sclera.			
C. Pagenstecher.				Cyclitis plastica.	Iritis.	Cataract.			Very deep excavation.	
Höring.			Indrawn scar.	Foreign body in ciliary body. Plastic and purulent cyclitis.	Anterior synechia.	Cataract.				
Just.	Scar with incarceration of iris.			Purulent cyclitis.	Purulent iritis.		Detached. Purulent choroiditis.	Detachment.		
H. Pagenstecher.			Scar.	Plastic and purulent cyclitis. Detached.	Plastic and purulent iritis.		Purulent choroiditis.	Detachment.		

TABLE I. Continued.

IV. *Eyes enucleated for sympathetic irido-chorioiditis.*

Number and name of the author.	*Cornea.*	*Sclerotic.*	*Corneo-scleral margin.*	*Ciliary body.*	*Iris.*	*Lens and vitreous body.*	*Choroid.*	*Retina.*	*Optic nerve.*	*Ciliary nerves.*
Bader.				Plastic cyclitis.	Plastic iritis.		Purulent choroiditis.	Hyperæmia. Detachment in periphery.		
Geo. Lawson.	Scar.			Atrophy.	Atrophy.		Atrophy.		Atrophy.	
Arn. Pagenstecher.	Scar.	Round-cell infiltration along the vessels and nerves.		Purulent cyclitis.	Purulent iritis.		Purulent choroiditis.			
H. Müller.				Plastic cyclitis.		New-formed connective tissue in vitreous chamber.	Plastic choroiditis.	Detached and degenerated.		
Arn. Pagenstecher.				Plastic cyclitis.	Purulent iritis. Anterior synechia.		Purulent choroiditis. Sarcoma.	Detachment. Atrophy.		
I. I. Maats.		Scar in which iris, ciliary body, and choroid are embedded.		(Purulent?) cyclitis.		Lens substance absorbed. Hemorrhage in vitreo.	(Purulent?) choroiditis.	Retina wanting.		One makes part of the scar-tissue.
"		Scar in the ciliary region in which iris is embedded.			Plastic iritis. Anterior synechia.					One makes part of the scar-tissue.
Savary.	Scar.	Scar in which choroid and retina lie.				Cataract adherent to the scar. Hyalitis around a foreign body.		Partial detachment.		
H. Knapp.				Plastic cyclitis.	Chronic iritis.	Chalky cataract.	Plastic choroiditis. Ossification.			Normal.
"				Plastic cyclitis.	Plastic iritis.		Plastic choroiditis. Ossification.	Detachment.		Normal.
"				Plastic cyclitis.	Plastic iritis.		Plastic choroiditis. Ossification.	Detachment.		

Geo. Lawson.	Scar.			Plastic cyclitis. Foreign body lying on the ciliary body.				Detachment.		
H. Pagenstecher and C. Genth.	Scar with adhesion of the lens.			Purulent cyclitis. Foreign body in the ciliary body.	Purulent iritis.					

V. *Eyes enucleated for sympathetic affection of the Retina.*

A. Alt. 32.	Scar.			Plastic cyclitis. Drawn forward. Partial atrophy.	Atrophy after iritis with total anterior synechia.		Serous choroiditis.	Detachment. Atrophy and pigmentation.		Normal.
V. Graefe.			Scar after extraction of cataract.	Plastic cyclitis.	Plastic iritis.	Chalky lens dislocated into the anterior chamber.	Plastic choroiditis.			
"							Chronic choroiditis. Chalky deposits.	Detachment.		
J. R. Pooley.			Scar with incarceration of iris and ciliary body.	Purulent cyclitis.	Purulent iritis.		Purulent choroiditis. Partial Atrophy.			Normal.
"	Staphyloma.			Atrophy after plastic cyclitis.	Atrophy.	Small remnants of lens.	Purulent choroiditis. Partial atrophy.	Detachment.		

VI. *Eyes enucleated for sympathetic affection of the Cornea.*

I. I. Maats.				(Purulent?) cyclitis.			Plastic choroiditis.	Detachment.		Some fatty degeneration.
A. Pagenstecher.	Scar (after operation for staphyloma) again staphylomatous.			Plastic cyclitis.	Plastic iritis.	Small remnants of lens.				

	Varieties of sympathetic affections (v. anat. description).						
TABLE II.	I.	II.	III.	IV.	V.	VI.	Total.
Scars in the cornea proper	19	9	3	11	2	1	45
Incarceration of iris in these scars	6	3	1	4	1	1	16
TABLE III.							
Scars in the sclera proper	13	1		4			18
Scars in the ciliary region with incarceration of ciliary body, or choroid, or both	6	1		3			10
Staphyloma	3						3
TABLE IV.							
Scars in the corneo-scleral margin	14	4	1	10	2		31
Incarceration of a part of the uveal tract in these scars	7	3		6	1		17
Of these scars the following are due to a previous operation	5	2	1	1	1		10
Incarceration of a part of the uveal tract in these	2	1		1			4
TABLE V.							
Affections of the ciliary body	38	13	1	26	4	2	84
Plastic cyclitis	19	8	1	17	3	1	49
Purulent cyclitis	11	3		14	1	1	30
Atrophy	1	3	1	2	2		9
Wounds and foreign bodies	10	2		3			15
Tearing and detachment	8	3		4	1		16
TABLE VI.							
Affections of the iris	35	11	1	23	4	1	75
Purulent iritis	9	6		13	1		29
Total anterior synechia	3	1		4	1		9
Total posterior synechia	6	3		7	1	1	18
Atrophy	5	2		1	2		10
There were irido-dialysis once, and irideremia three times.							
TABLE VII.							
Affections of the lens and vitreous body	39	5	2	15	2	1	64
Chalky cataract	2	1		3			6
Dislocation of lens	4			1	1		6
Lens wanting	5	2	1	1			9
Foreign body in it	5	2					7

	Varieties of sympathetic affections (v. anat. description).						
	I.	II.	III.	IV.	V.	VI.	Total.
Table VIII.							
Affections of the choroid	38	12	3	23	4	1	81
Purulent choroiditis	6	2	1	13	2		24
Plastic choroiditis, ossification, chalky deposits.	8			3	1		12
Atrophic choroiditis	4	2		1	1		8
Detachment of choroid	8	2		4			14
Tumors of choroid			1	1			2
Table IX.							
Affections of the retina	45	9	3	20	3	1	81
Detachment	33	8	2	17	3	1	64
Table X.							
Affections of the optic nerve	14	6	1	11		1	33
Optic neuritis	2	1		5			9
Atrophy after neuritis	6	4		4	1		15
Glaucomatous excavation	5			4			9
Granuloma optici intraoculare traumaticum existed in one instance.							

The histological condition of the ciliary nerves has been mentioned in forty-three of the cases.

They are normal thirty-four times.

Torn and compressed *without* histological changes three times.

They enter into the formation of the cicatrix four times.

They are in a process of fatty degeneration or atrophy three times.

Schwann's sheath was found thickened three times, and containing chalky deposits once.—

Decided purulent panophthalmitis was found in twenty-one instances.—

The time which elapsed between the affection of the eye first diseased, and the appearance of sympathetic symptoms in the other eye has been mentioned in fifty-eight of the cases. It is severally :

TABLE XI.

Number of days.	Number of cases.	Number of years.	Number of cases.
7	1	3	4
8	2	5	3
Number of weeks.		6	1
		7	3
2–5	7	12	2
5–9	7	13	1
Number of months.		14	2
		17	1
2	4	20	1
3	2	25	1
4	1	27	1
5	1	29	1
6	3	30	1
10	2	40	1
Number of years.		45	1
		50	1
2	2	60	1
			58 cases.

Thus the percentage of cases, in the first two months, 36⅓ per cent.; between the end of the second month and the first year, 15½ per cent.; between the end of the first and tenth year, 22¾ per cent.; between the end of the tenth and twentieth year, 12 per cent.; between the end of the twentieth and the sixtieth year, 13⅓ per cent.

Sympathetic affections resulting from extraction of cataract..... 5 times.
Reclination..... twice.
Iridectomy..... 3 times.
Division of soft cataract..... once.

Idiopathic inflammation without preceding traumatism of the globe was the cause in 16½ per cent. of the cases. Corneal or scleral cicatrices, with incarceration of a part of the uveal tract, are found in 39 per cent. Affections of the entire uveal tract, or of a part of it, exist in 99 per cent. of the cases and a fraction; purulent panophthalmitis in 19 per cent. Affections of the optic nerve and retina in 79 per cent., among which detachment of the retina in 58 per cent. Detachment of ciliary body and choroid in 20 per cent. Histologico-morbid alterations of the ciliary nerves were observed in but 16⅔ per cent. of the cases. Only one case presented but a retinal affection. 73 per cent. had affec-

tions of the uveal tract and the retina. In 27 per cent. of the cases the uveal tract was affected without a retinal complication.

The symptoms of sympathetic *irritation*, which are described by all authors as photophobia, lachrymation, paresis of accommodation, pain, and photopsia, appeared in 52 per cent. of the cases. 98 per cent. of these cases had affection of the uveal tract; 90½ per cent. affections of the retina and optic nerve.

Sympathetic *iritis* had set in in 13⅔ per cent. In 100 per cent. of these cases the uveal tract was affected; the retina and optic nerve in 62 per cent.

Sympathetic *irido-cyclitis* was observed in only FOUR (!) of 110 cases (3¾ per cent.). The enucleated eyes presented affections of the uveal tract 3 times, and of the retina and optic nerve 4 times.

Sympathetic *irido-choroiditis* had set in in 27⅓ per cent., in all of which the uveal tract was affected. Purulent panophthalmitis occurred in 43⅓ per cent. of these cases. The retina and optic nerve were affected in 73⅓ per cent.

But 5 eyes (4½ per cent.) were enucleated for sympathetic *neuroretinitis*. The uveal tract was affected in all, and the retina and optic nerve three times—60 per cent.

Only 2 globes were removed for sympathetic affections of the *cornea* ($1\frac{9}{11}$ per cent.).

Conclusion.

The above statistics show the cause of the sympathetic affections, necessitating enucleation, to be traumatisms in 83½ per cent. cases, leaving 16½ per cent. of the cases attributable to idiopathic inflammation. In 39 per cent. of the 110 eyes, we encounter injuries to the hard membranes, with incarceration of a part of the uveal tract, *i. e.*, in 62¾ per cent. of all the injuries. Among those eyes which were destroyed by idiopathic inflammation, ⅔ presented ulcerations of the cornea, with incarceration of the iris, or the formation of staphyloma. Consequently, the percentage of eyes which were the cause of sympathetic troubles, without presenting cicatrices in the hard membranes, is very small (about 5 per cent.); and among these should be especially cited those with chalky deposits and ossifications. In 44½ per cent. the cases of injury to the hard membranes no part of the

uveal tract was attached to the wound. These cicatrices are always combined with internal changes. Cicatrices and foreign bodies in the ciliary body or incarceration of it—which are usually looked upon as the most important factor in sympathetic affections—appear in only 17¼ per cent., while the affections of the ciliary body all together amount to 76½ per cent. The iris is changed in but 68 per cent. and the choroid in 73 per cent., thus showing almost the same number of changes in each of the parts of the uveal tract, with only a slight percentage in favor of the ciliary body.

The percentage of changes in the retina and the optic nerve is remarkably great—79 per cent.; of the retina alone 73 per cent.; and in 58 per cent. of these the retina is detached. Notwithstanding the fact that there is but one case described in which there was an affection of the retina without coincident affection of the uveal tract, it appears to me that the great percentage of affections of the retina and optic nerve should engage very earnest consideration—the more so, as there are but 16⅔ per cent. which present changes in the ciliary nerves.

What part transmits the affection from one eye to the other? If it were the ciliary nerves, diseased in structure or function, v. Graefe's proposition to divide them should have led to a favorable result. If it were the inflamed optic nerve and retina, the section of the optic nerve would have proved more successful. From the preceding statistics I conclude that the views of many earlier authors—*i. e.*, that the optic nerve plays a great part in the transmission of sympathetic ophthalmia—is strongly sustained, and its action in this respect is attributable as much to inflammatory as to functional changes. Transmission of inflammatory changes appears quite possible, if we bear in mind the semidecussation of the optic nerve-fibres in the chiasm, as demonstrated by the cases of *Iwanoff*, *Hirschberg*, *Pooley*, and others, while Mooren (Symp. Gesichtsstörungen) gave the supposition of functional changes a very plausible explanation; but it seems to me that he underrates the influence of the optic nerve. The transfer of affections by the ciliary nerves can only be accomplished by reflex action, since their tissue possesses a great power of resistance. (See H. Müller.) It appears to me that the entire nervous apparatus of an eye has the power of transmission; and even the influence of the sympa-

thetic system must not be left out of view in this consideration. In more than 99 per cent. of the cases we have to deal with changes in the vascular membrane of the eye—consequently with disturbances of the entire circulatory system. It is hardly presumable that these disturbances should not exert an influence upon the sympathetic fibres of the uveal tract.

The individual varieties of sympathetic affections in the second eye are certainly nothing but differences of degree. I do not now allude to the two eyes, enucleated for sympathetic corneal affections, although Galezowsky, too, cites two such cases. They appear doubtful to me, to say the least. There can be no incontrovertible assertion, that the locality of the primary affection would determine a certain fixed kind of affection in the other eye. Still it is worth mentioning that in 13 of the cases where eyes were enucleated for sympathetic *irido-choroiditis*, the other had been lost by *panophthalmitis purulenta*, and that of the five, enucleated for *neuroretinitis sympathica*, three showed retinal detachment.

FROM THE FOREGOING WE MAY DERIVE THE FOLLOWING PRACTICAL DEDUCTIONS:

1. The entire nervous apparatus of the diseased eye participates in the transmission of the affection to the other.

2. Scars in the hard membranes, whenever combined with alterations in the other parts of the eye, particularly in the uveal tract, retina or optic nerve, are capable of calling forth sympathetic affections of the other eye, at any time.

3. Purulent panophthalmitis makes no exception.

4. Consequently its artificial production, as a prophylactic measure against sympathetic affection, is reprehensible.

5. The time at which sympathetic affections most frequently manifest themselves varies between seven days and eight weeks, after the beginning of the disease of the first eye.

6. As soon as the first trace of a sympathetic affection manifests itself (a diagnosis which should be made with the greatest care), therapeutic measures should be resorted to.

7. The only efficient means consists in enucleation of the eye first affected.

8. When it is fairly presumable that the affection has extended

to the optic nerve, the removal of a large piece of the nerve, together with the globe, should not be omitted.

9. Should a case come under our treatment in which the iris or capsule of the lens is incarcerated, the incarcerated iris or capsule should be freed before sympathetic irritation has made its appearance. In recent cases an abcission of the prolapse, with or without iridectomy, will obviate, in most cases, the impending danger of sympathetic ophthalmia.

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ON THE VASOMOTORY AND SECRETORY NEUROSES OF THE EYE.*

BY DR. H. SCHLIEPHAKE.

CONDITIONS which we have to consider as vasomotory and secretory neuroses of the eye, and to treat as such, are by no means rare. In literature statements concerning them are sparse and isolated; but accurate clinical observation teaches that they often exist, partly as independent affections, partly as accessories and complications of the material diseases of the eye.

It is well known that *Donders* considers glaucoma simplex as a secretory neurosis. Reflex irritations of the trigeminus causes, according to him, an increase of the secretions and consequent increase of pressure in the eye. In spite of the opposing authority of *v. Graefe*, who was more inclined to insist upon the inflammatory character of glaucoma, this theory has found considerable favor. The counterpart of the neurosis causing increase of secretion, *i. e.*, the neurosis which causes a *decrease* of it, has not yet received its proper consideration. *Bowman*† has briefly referred to such occurrences in the course of glaucomatous affections, and *v. Graefe*‡ and *Nagel*§ have termed them *essential phthisis* bulbi. *Nagel* then pointed to the frequent occurrence of similar conditions under the picture of mild ophthalmia,‖ yet the knowledge, and, still more, a thorough explanation of those phenomena are still very unsatisfactory.

The anomaly of the intra-ocular secretion in these cases is evidently founded upon a transitory and often rapidly changing disturbance of the nerves, in contrast to the phthisical softening of the globe caused by the disorganization and partial destruction

* The observations which form the basis of this paper have been collected in the ophthalmic clinic of Prof. *Nagel*, at Tübingen.

† London Ophth. Hosp. Reports, Vol. V., page 1. (1865.)

‡ Arch. f. Ophth. XII., 2, page 256.

§ Arch. f. Ophth. XIII., 2, page 407.

‖ Klin. Monatsbl. IX., page 335.

of the vessels; but we are in want of sufficient data to determine their nature, so much the more as the process of intra-ocular secretion as yet remains unexplained. Whether the secretion in the interior of the eye consists in a mere filtration through the walls of the vessels, or in a more complicated secretory process, standing under the, chemically separating, influence of epithelial formations; whether there exist special nerves of secretion, or whether the nerves of the vessels discharge these functions, in particular, whether there are only contracting or also actively dilating fibres, which act either directly or indirectly upon the vessels; in which manner the regulation and preservation of intra-ocular pressure is kept at a constant elevation through the change of blood-pressure and other influences,—these are all questions about which nothing definite is known, and which have only recently incited discussion. It is, therefore, easily understood that it is as yet completely doubtful whether the secretory anomaly in question is to be considered as a secretory or simply as a vasomotory neurosis, as a phenomenon of irritation or of paralysis, as an affection of the sympathetic or of the trigeminus.

Clinical observation seems to be called upon to clear up many a point by its own light, and even, for the present, to anticipate physiological investigations, and to define the problems which physiology, in this chapter, has to solve.

Observations.

In the course of the present and also of the past session (winter 1872–73, and summer 1873), Professor *Nagel* presented several cases in which transitory diminution of tension of the globe—they may be called hypotony, in opposition to hypertony, an increase of pressure—formed a striking symptom. The occurrence of considerable hypotony in the course of chronic diffuse parenchymatous keratitis, to which v. Graefe had already drawn attention, was frequently observed in all grades. To this category belong only cases uncomplicated with inflammatory processes in the iris or ciliary body, which are free from synechiæ, and in which the state of softness is only transient. Transitory vasomotory and secretory neuroses with hypotony appear also in other diseases of the cornea, especially in phlyctenular, vascular as well as non-vascular forms, so that after the termination of the disease the

pressure again becomes entirely normal. The following case was very remarkable:

A traveling baker-apprentice, Gr., suffering from a trachomatous pannus, which covered the upper half of the cornea, suddenly felt, probably in consequence of improper and too irritable treatment, violent pain in his left eye, with a strong diminution of pressure (T—2). On the cornea there was a central abscess, no sign of iritic exudation; the eye was greatly injected, and although it was not very sensitive to the touch, yet the pain was so violent that he groaned, and was deprived of his sleep for several consecutive nights. It was only momentarily and imperfectly soothed by hypodermic injections of morphium. The pupil was insufficiently dilated by atropine, and during the night almost always contracted again. Only after the violent neuralgic pain had abated, a permanent dilatation of the pupil was effected. The assertion, however, may be reversed: the pain ceased when the pupil was permanently dilated. But for days the atropinized pupil still showed a great tendency to contract over night, and then each time the tension decreased, while during dilatation of the pupil it remained normal. Thus a sure conclusion in regard to the tension could be made from the size of the pupil. A noticeable difference in the temperature of both sides could not be ascertained. At the end of two weeks the acute affection was removed simultaneously with the filling up of the ulcer, the tension of both eyes was alike, and all pain had disappeared. The effect of Plumb. acet. upon the trachomatous conjunctiva was borne well, and the case differed now in nothing from numerous cases of the same kind.

Professor *Nagel*, on the occasion of a discussion in the Ophthalmic Society of 1871, at Heidelberg, stated that he had repeatedly observed affections of the eye with a great diminution of the intra-ocular pressure, under the picture of mild ophthalmia, without any considerable material participation of the external parts of the eye, especially without any change in the cornea or iris. Such cases of decided vasomotory and secretory alteration appear without any traumatic or other known cause, mostly in one eye only, but occasionally also in both eyes alternately. Some of them show no vestige of phlyctenular eruption; others show slight and unimportant inflammatory opacities; others, again, very scant development of vessels in the cornea. Of the numerous cases belonging to this group, a few may be mentioned, especially such as were distinguished at the same time by marked local changes of temperature.

A healthy boy, G. H., aged 11, was, without known cause, taken sick on one eye, with mild symptoms which were taken for catarrhal conjunctivitis, and treated as such. Astringent collyria rather aggravated than improved the condition, which had continued for some time. A closer examination revealed a moderate injection of the conj. palpebralis, a marked injection of the superficial as well as of the deeper vessels of the conj. bulbi, increasing in the direction of the cornea. The sclero-corneal juncture was hyperæmic and somewhat swelled; but no trace of a phlyctenular eruption could be discovered. The cornea was clear; the sight was slightly impaired; the pupil somewhat narrower and dimmer than in the healthy eye; and the tension of the diseased eye was so strongly lowered as to occasion a suspicion of a severe internal affection of the eye. Besides, a feeling of a troublesome and painful pressure was present. Atropine and luke-warm lead-water fomentations soon relieved the subjective symptoms, and recovery ensued in about a fortnight. The difference of tension in both eyes disappeared, and the sight was alike in both.

In this case no measurement of the local temperature was made, but in the following cases it was.

A young girl, Eliza T., aged 16, from the neighborhood of Tübingen, was taken with an acute affection of the right eye, whose origin was dated back to a cold. In the parenchyma of the cornea was found an inconsiderable grayish infiltration, diffuse and more intense in the centre. In some places delicate pencils of vessels stretched more than one millimetre over the edge of the cornea, without reaching the central opacity. Besides, there were symptoms of irritation, narrow pupil, pronounced decrease of tension, and increase of temperature by several degrees in the vicinity of the eye over that of the same places on the healthy side. Under the effect of atropine and warm-water applications, the symptoms of irritation disappeared in a few days; as soon as the pupil was ad maximum dilated, the tension and temperature became normal, and the entire affection took a very rapid and favorable course.

Such cases are frequent, and, concerning their prognosis and treatment, it is important to know that they show a very active participation of the vasomotory nerves, which is quite disproportionate to the comparatively insignificant structural changes.

Katharina B., aged 22, from Waldorf, related, at the time of her presentation at the clinic, that since childhood her right eye had been very weak.

Eight weeks before, a flail had struck and wounded the upper lid of the same eye. After a fortnight, the trifling effects of the injury had disappeared, when she, according to her opinion, caught a cold, and contracted a new affection of the eye.

The left eye was entirely normal. The lids of the right eye were some, what swelled; the conjunctiva palpebralis and bulbi was injected; the cornea hazy, with some very small marginal phlyctenulæ; the iris healthy and no abnormity could be discovered with the ophthalmoscope. Under local treatment the eye improved during the next few days; when, quite suddenly, an exacerbation set in. When awaking in the morning, she felt violent pain in the right eye and temple, coming in attacks of about half an hour's duration, with abundant secretion of tears. These attacks frequently recurred. The tension of the right eye was greatly reduced (T—2).

Remarkable, and of importance for the diagnosis, was the state of the temperature in the surroundings of the healthy and the diseased eye. Whilst during the intermissions the temperature in the vicinity of the diseased eye was 3° C. higher than on the other side, and sometimes, at especially favorable moments, no difference of temperature at all was noticed; during the paroxysms the temperature was 2° C. lower on the affected than on the healthy side. Twice it happened that this change was observed in its beginning. In the first instance, an elevation of temperature of 1.5° C. was observed on the suffering side; when the attack of pain set in, it not only disappeared, but, before my own eyes, the mercury in the thermometer, which was applied to side of the diseased eye, sank in such a manner that in a few minutes it was 2.1° C. lower than on the other side. In the second instance, a diminution of temperature by 2.5°, which had, on the affected side, been constant for an hour, disappeared, towards the end of the paroxysm, so completely that during the next hours no difference of temperature on the two sides was observable.

Whilst the differences of temperature were thus changing, the differences of pressure showed the same proportion—that is, during and after a more violent attack of pain, the eye was softer (T. 2), and resumed the normal tension during intervals of rest.

Injections of morphine produced a passing and favorable effect, as they diminished the symptoms of irritation; but the return of such attacks could not be prevented. Only after frequently repeated injections could recourse again be had to the solution of argentum. After a suffering of several weeks, the differences of temperature and pressure gradually and permanently disappeared, and the patient could be dismissed as cured.

Sometimes the picture under which the vasomotory disturbance with hypotony appears, is in so far changed as a moderate ciliary

injection is connected with an *intense hyperæmia of the conjunctiva palpebralis*, a scant mucous, but copious lachrymal secretion. Such cases, which are thus plainly enough to be distinguished from ordinary catarrhal inflammations, are not benefited by irritative treatment with nitrate of silver and the like, and have a milder course under expectant and narcotic treatment. Only after the narcotica have produced a sufficient effect, a careful application of astringents can be of any use.

The following is an example of this kind, which occurred in the fall of 1872:

Mr. H. G., of Stuttgart, had in former years a painful accommodative affection (hyperæsthesia of the ciliary muscle, according to *Nagel*), which, at that time, had been entirely removed, but since then had several times returned for very short periods. A few times also mild catarrhal affections had occurred. Towards the end of September a sudden affection of the right eye set in, consisting in redness, copious lachrymation, intolerance of light, and pain, with a scanty secretion of mucus. Local treatment, finally, with calomel, rather impaired than improved the condition. The examination exhibited a vivid, almost bluish-red injection of the palpebral conjunctiva, a less pronounced ciliary injection, a small grayish-white spot at the lower edge of the cornea, and very slight secretion of mucus; on the other hand, there was a strong flow of tears, whilst during a state of quietude, and after a painful stitch in the eye, a copious flow would set in periodically, at intervals of about ten minutes. The pupil was narrowed, the tension of the eye was greatly diminished, both absolutely and relatively to that of the left eye (T—2). During the free intervals the vision was not materially altered, and nothing abnormal was discovered by ophthalmoscopic examination.

After an injection of morphia, the attack of pain, with its consequent flow of tears, vanished for some hours; the tension of the eye became increased, and but a slight feeling of painful pressure remained. The immediate influence of the injection of morphia upon the pressure was repeatedly observed in the further course of the affection, and the more violent attacks of pain, which were always connected with hypotony, were thereby removed and even prevented when their approach was felt.

Injections of strychnine seemed to be indicated by their striking influence upon the vasomotory nerve centre, as lately demonstrated by *Sigmund Mayer*,* and were resorted to several times; but owing to the fact

* Report of the Sessions of the Academy of Vienna, Cl. XLIV., Part II., Nov. 1871; and in *Nagel's* Annual Ophthalmic Journal for 1871, page 206.

that other remedies were given at the same time, no positive proofs as to the action of the strychnia could be gained. At all events, the course of the affection was very favorable. After a fortnight's clinical treatment, the patient was discharged, but remained under observation for some time, and then went home cured.

Towards the end of his cure, the patient, who had been carefully observed, stated that at one time in the course of his disease the pain suddenly skipped from the right to the left eye, which until then had been but moderately injected and very slightly affected.

Whilst, from this time on, the right eye was painless and showed a normal tension, the left eye, until the next day, remained very painful, irritable, and soft, without however showing the least trace of a corneal affection.

The appearance of a decrease of tension after a traumatic cause has frequently been observed by Professor *Nagel*, and deserves especial attention. An injury was also the probable cause in the first case published by *v. Graefe*. A wound, received ten years before, had left a scar in the conjunctiva; and, throughout this time, attacks of violent neuralgia set in for hours, accompanied by dread of light, lachrymation, and a marked diminution of tension of the eye.

In the case published by *Nagel*, the operation of strabismus was the cause of the entirely painless hypotony of the eye, connected with a strong hypersecretion of tears, and this condition lasted continuously for several weeks. Quite a similar case, also after an operation of strabismus and with an equally favorable issue, was observed by him several years later. Possibly an injury of the ciliary nerves by the strabismus hook may have been the cause. But also injuries of another kind, and especially contusions of the eye, were followed by hypotony; after a slight burning, hypotony was also observed. The milder cases of such injuries, showing no material alteration of the eye, are of particular interest as regards the disturbances of the functions.

A boy, G. M., aged 13, while working in a smithy, had a piece of steel, several inches long, thrown against his right eye; two days later, on the 28th of April, he presented himself. An unimportant excoriation on the right wing of the nose is almost healed; the eye shows no wound, only ciliary and slight conjunctival injection—the latter more marked at a point near the outer and lower quadrant of the cornea, and in the cor-

responding portion of the transition-fold, where some whitish mucus is firmly deposited, as is often seen after a cauterization or slight burn.

From this point, a colorless cord, one-half inch in length, evidently an ectatic lymphatic vessel,* is seen taking its course superficially above the vessels and towards the cornea, whose edge at this place presents a slight dimness and irregular reflection.

The right palpebral slit is lower than the left, the pupil narrower; upon diminution of the intensity of illumination, the left pupil becomes much more dilated than the right. On thorough examination, especially with focal and ophthalmoscopic illumination, a very fine, nearly perpendicular corneal wrinkle is discovered. The tension of the right eye is greatly diminished (T—2), the temperature in its vicinity, $\frac{1}{2}$° C. higher than on the left. The sight of the injured eye is diminished, and the formerly full-sighted eye distinguishes only Sn. $\frac{1}{10}$, but with weak negative glasses (40 and 50), tolerably well $\frac{1}{30}$.

There seemed to exist a slight spasm of accommodation, *i. e.*, a limitation of accommodation, in the direction of the far point.

In the background of the eye nothing abnormal was noticeable. The boy soon withdrew from observation, probably because the slight disturbance had disappeared.

In another case, that of H. K., of Reutlingen, the course of the affection could be better observed. (January, 1871.)

A powerfully thrown snow-ball had hit the left eye and very much disturbed the sight. On the same day the injured man was examined; he had no external injury; there was, however, found a ciliary injection and a markedly diminished consistence (T—2), with a violent pain. The pupil was irregular and sluggish; the floor of the anterior chamber was occupied by a hyphæma; the aqueous humor was turbid. Repose in bed and instillations of atropine in a few hours effected an abatement of the pain and an absorption of the hyphæma. On the following day the same hypotony still existed; but the pupil was widened, the aqueous humor clear, and the finest print was read. During the course of the day, after the patient had left his bed without permission, a sudden exacerbation ensued, with violent pain and diminution of sight. On the iris, near and around its ciliary attachment, small patches of extravasated blood were seen at different places, and upon the floor of the anterior chamber a very minute hyphæma; but the rest of the anterior chamber was filled with a

* Such lymphangiectasiæ were also repeatedly seen in other cases—for instance, in cases of circumscribed episcleral injection; furthermore, in chronic hyperæmia after an old powder burn.

large, semi-transparent coagulum.* It lasted a week before the exacerbation had entirely subsided; at that time the normal sight and tension were restored; but the pupil remained dilated, in spite of the discontinuance of atropine, and it required the instillation of extract of calabar to render the pupil normally movable.

A barber, O. B., aged twenty-five, was presented during the summer session of 1873. He had received a blow upon the left eye with the tipped end of a cane. The eye was hit from the left side and from above downwards. A bright flash was perceived. At first a violent pain was felt; this, however, soon subsided, and a sensation of pressure remained. The injured eye saw everything in a mist and with a central black spot, which, however, had disappeared by the next day. The patient also had a subjective perception of colors, especially of red and yellow.

The patient presented himself on the morning after the reception of the injury. The lids of the left eye showed no trace of the blow, which seemed rather to have hit the globe directly, particularly the cornea. The eye presented a moderate conjunctival and ciliary injection, watered somewhat, and shunned the light. The lower part of the cornea appeared somewhat hazy; a circumscribed opaque spot occupied the centre, and from there extended in an outward direction; the aqueous humor did not seem to be perfectly clear. The pupil was a little wider than that of the right eye, but perfectly movable. In its lower portion the iris appeared swollen and its fibrillary structure blurred. On the lower ciliary margin a thin violet-red streak of blood was seen (contusion of the iris). A distinct difference of tension in the two eyes could not be perceived—perhaps the injured eye was a little harder; in the afternoon, however, and during the following days the left eye was softer (T—1). The latter was somewhat sensitive to pressure; the left palpebral fissure a little smaller than the right. The temperature, measured on the closed upper lids, was almost 1° higher on the left than on the right. Sight is diminished; whilst

* Such a translucent coagulum (extravasation of lymph) appeared also lately (on the 15th of April, 1873) in the case of a laborer employed in the gun factory at Oberndorf, after a violent contusion caused by the sudden flying off of a piece of steel. The coagulum showed the characteristics described by *H. Schmidt*, and could be likened to a lens dislocated into the anterior chamber. The rapid and concentric diminution of the coagulum soon cleared all doubt.

the right eye has an almost normal acuteness of vision with—36; the left distinguishes with the same glass only $\frac{15}{60}$. In close proximity only Jäger No. 2 is read, this being the distance (about five inches) at which the right eye reads No. 1; a considerable paresis of accommodation is not present; field of vision and perception of colors normal. The ophthalmoscopic picture was a little veiled, on account of the slight dimness of the cornea; the papilla seemed to be somewhat more reddish on the left side than on the right; nothing else.

Atropine in very large doses widened the pupil slowly and imperfectly. A maximum dilatation could not be effected in any direction. The pupil was wider above than below where the iris was swollen. The accommodation was paralyzed; the far point unchanged; and after a week's continued application of atropine the left eye showed H. $\frac{1}{60}$ (S. $\frac{15}{20}$), and the right M. $\frac{1}{36}$.

Absolute repose, the instillation of atropine, and the application of luke-warm poultices were not sufficient in the treatment of the case, for the pain became so violent that on the fourth day local blood-letting by Heurteloup's instrument had to be resorted to. After that all trouble disappeared; the tension and the vision of the injured eye became normal, and the form of the pupil regular.

The left eye of the boy, A. Z., aged fourteen, was slightly burned by a trifling explosion of powder. The patient presented himself three days afterwards. Lashes and eyebrows were singed, the lids slightly reddened and swollen, and the forehead was blistered at several points. The palpebral and ocular conjunctiva was greatly injected; the eye watered, was sensitive to pressure, and spontaneously painful at night. The cornea was clear, the pupil a little narrower than the right one and easily movable; vision almost normal, but the eye markedly softer than the other (T—1).

At the inner canthus of the left eye the temperature measured 1.3° C. more than at the corresponding point of the right. All the symptoms disappeared in a *few days*.

A new light was thrown upon these cases by a series of observations, in which, besides the morbid symptoms of the eye, also others were noticed, evidently connected with the former. The following are some examples taken lately:

Mrs. Hedwig S., from Hirschau, thirty years old, presented herself at the clinic, January 29, 1873. As a girl she had suffered

more or less from headaches, until the time of her marriage, *i.e.*, twelve years ago. She is a mother of seven children, nurses a child four months old, has been and is now healthy, with the exception of the affection to be described. Since two years she noticed a sinking of the upper lid of the right eye and a diminution of vision. Only since a few days her affection has become aggravated by the appearance of pains in the head, in the forehead and temple, especially on the right side, dread of light, flow of tears, sensation of pressure, and an intense itching in the right eye.

The examination shows a slight sinking of the right upper lid, which covers about one-third of the cornea, a marked, livid injection, with but slight swelling of the palpebral conjunctiva, without mucous secretion, and a trifling injection of the ocular conjunctiva. The right pupil is considerably narrower than the left, but is perfectly movable, and the tissue of the iris seems to be normal. Both the reaction upon light and the accommodative movement ensue regularly. In shadowing the eye and in relaxing the accommodation for distance, the difference in the width of both pupils becomes very marked. There is therefore a lack of dilatability of the right pupil.

Upon palpation the right eye shows a considerable decrease of tension, which however changes greatly within short periods of time. The manipulations resorted to during the repeated examinations apparently effected an increase of tension and an equalization of the difference of the two eyes.

The surrounding parts of the right eye, forehead, cheek, and ear appeared more reddened, also somewhat fuller than those of the left half of the face, and palpation showed a difference of temperature, which the thermometer confirmed. Generally the temperature of the right side amounted to something over 1° C. beyond, than that of the left; and at one time, when the tension of right eye was very low (T—2), the difference amounted to more than 3° C.

The picture of the disease here described must necessarily be considered a neurosis, since no material change could be demonstrated anywhere. Myosis is a well-known symptom of paralysis of the cervical sympathetic and of disease of the regio oculo-pupillaris of the spinal cord, caused by the cessation of the con-

tractility of the dilating fibres of the iris. Ptosis of the upper lid can be assigned likewise to paralysis of the sympathetic, especially in the absence of any mechanical cause and any indication of an affection of the oculo-motory nerve, since it is known that the non-striated muscular fibres, innervated by the sympathetic (musc. palp. sup. and inf., discovered by *H. Müller*), aid in the act of raising the lids. These are the very fibres, which, being spasmodically affected, cause a retraction of the lids in cases of irritation of the sympathetic, and thus produce the first symptoms of Graves' disease (defective sinking of the lids in looking downwards) described by *v. Graefe.*

A marked injection of the conjunctiva, not assignable to any direct cause, and unattended by any secretion of mucus, bears the stamp of a neuro-paralytic hyperæmia. Viewed in connection with the half-sided hyperæmia of the face and the corresponding increase of temperature, this condition may be considered as a paralysis of the sympathetic vaso-motor nerves.

It has been mentioned above that the decrease of the tension of the eye has been explained by *Nagel*, in other cases, as a symptom of paralysis of the sympathetic nerve. We may easily conceive that slight disturbances of vision are also caused by it, either from contraction of the range of accommodation and diminution of the state of refraction, consequent upon the insufficient support of the lenticular system by the Zonula Zinnii, or from a lack of transparency of the cornea consequent upon the loss of its normal tension. The other abnormal sensations in the eye, as, for instance, the feeling of tension, pressure, and itching, dread of light and lachrymation, have also been found in the above-mentioned cases, in connection with hypotony. The occurrence of half-sided megrim-like headache is worthy of notice, as a symptom met with in different states of irritation and paralysis of the sympathetic.

No well-grounded statement can be made as to the nature, cause, and seat of the affection, in the case under consideration. At present nothing can be said regarding the course of the affection. The application of the constant galvanic current, which Professor *Nagel* recommended, relying upon its good results in identical and kindred cases. has not yet been tried, as the patient

lives in the country, and could not separate herself from the child whom she nurses.

Soon after, on the 19th of February, Rosa H., from Heilbronn, 34 years old, presented herself at the clinic, seeking advice on account of a slight but obstinate conjunctival affection.

A few months before, the affection had been treated as a catarrhal one, without satisfactory result, and the symptoms of pain persisted. After a periodical improvement, an exacerbation set in fourteen weeks since. The conjunctiva palpebralis of the left eye now appeared hyperæmic, in a moderate degree, and the patient had a constant sensation of pressure and friction in that eye. Upon examination, a difference in the width of the two pupils was at once noticed; but the patient stated that this had been so for years. The left pupil is the narrower of the two; it is movable, and contracts readily upon the admission of light, and in the efforts of accommodation, always however, remaining narrower than the right. After the instillation of atropia, a marked dilatation occurred, which lasted but a short time. Contraction had begun a few hours after the use of the atropia. The left upper eyelid was somewhat sunken, but could be raised as high as the right, so that, whilst the left palpebral fissure was generally lower than the right, the difference disappeared through an effort.

By palpation the left globe showed a distinct decrease of tension, which moreover varied from day to day, nay, even from hour to hour. Sometimes the finger could hardly detect a difference of tension.

The left cheek showed greater redness than the right; but this symptom varied also greatly, and was more distinctly noticeable in a cold than in a warm room. Even to the simple touch the temperature showed differences, which were determined by the thermometer. The temperature of the left cheek was generally about $\frac{1}{2}$ 1–2, sometimes more than 3° C. higher than that of the right. The patient related that, since her sixteenth year, she only perspired on the right side of the face, while the left cheek remained cool and pale. A close comparison of the two sides of the face showed the left to be somewhat hypertrophic.

Apart from the absence of the half-sided headache, the symptoms in this case are very similar to those of the preceding one, and the diagnosis of a subparalytic condition of the cervical portion of the sympathetic can for this reason be made here with the same right as there. (In the case under consideration the left side is affected.)

Additional symptoms appeared in this case, completed the

picture of the disease, and threw a new light upon the state of things.

The ophthalmoscopic examination of the background of the eye, which gave a negative result in the first case, showed a small variation in the second. Here the optic nerve entrance of the left eye appeared a little redder by capillary injection, and the retinal vessels somewhat wider than in the right. I say appeared, because the difference was very small, and, as no micrometrical measurements were made, not absolutely positive.

But a more positive statement can be made concerning the sight, which was not as good in the left eye as in the right. With M. $\frac{1}{36}$ the right eye showed normal S. ($\frac{1}{16}$), while the left had but $\frac{3}{4}$ ($\frac{1}{20}$). The right eye could easily read Jäger 1 in close proximity, while the left eye distinguished only Jäger 2, and required the aid of a convex glass in order to discern Jäger 1. The near point of the left eye, examined with a trellised optometer, was found at a distance of 6¾ inches. There existed consequently a certain limitation of the range of accommodation in the direction of the near point. A similar limitation was also ascertained in the direction of the far point, because, after the instillation of atropine the left eye showed no more M. $\frac{1}{36}$, a spasm of accommodation of the dioptrical value of $\frac{1}{21}$ existed at the same time.

Finally, another interesting circumstance in regard to the localization of the affection was brought to light. The part of the neck near the angle of the lower jaw, corresponding to the position of the upper cervical ganglion, showed a complete want of sensibility upon pressure on both sides, and the patient stated that she knew those places, "since every cold settled in them." The cervical vertebræ were not abnormally sensitive upon pressure.

At the end of the winter term, a third case was clinically observed, which, even if deviating in certain points, evidently belongs to the same category with those last mentioned.

The patient was a delicate, consumptive woman, Karoline Gr., from Tübingen, who had been under treatment for some time on account of asthenopia. Subcutaneous injections of strychnine and convex glasses had formerly removed the disorder and satisfied the patient. Since five months a headache of the left side had set in, constant but varying in severity, and occupying principally the region of the parietal bone, and thence spreading more forwards than backwards. Combined with it are

general debility, nervous irritability, strong psychical emotion on slight occasions, and fits of bad temper. In remembrance of the former asthenopia, the principal symptoms were referred to the eyes, which show but little abnormity. In consequence of the increased sensibility to bright light, the narrowly cut lids are pressed together, blink and tremble; the glance is uncertain, and the eyes water easily.

The disturbance of sight does not at all sufficiently explain these phenomena. The right eye has been highly amblyopic a long time with Hm. $\frac{1}{30}$, diverges when the patient looks at near objects, and is therefore almost of no account in regard to vision. The left eye shows no Hm.; after atropinization H. $\frac{1}{36}$ with S. $\frac{1}{30}$ to $\frac{1}{20}$.

The accommodation is somewhat limited. The patient reads Sn. 3; with convex glasses also the numbers 1 and 2. The convex glasses, however, which had rendered the woman good service for some time, did not relieve her present trouble. A careful examination proved indeed that still other pathological signs were present. The left eye showed, in comparison to the right, a somewhat narrower pupil, a smaller palpebral pressure (the upper lid being somewhat sunken and the lower a little raised), the left globe was softer than the right, the skin at least periodically redder on the left side of the face next to the eye. On the left side of the forehead thermometrical measurements showed a temperature of 0.8° C.; in the external auditory meatus of 1.5° C. beyond that of the corresponding points of the right side. Once, however, in the evening, and at a time when the patient felt comparatively well and was free from pain, and when the differences in the size of the pupil, palpebral fissure, and tension of the globe were hardly noticeable, the left side of the face appeared paler and its temperature about 2° C. lower.

Also, in this case there existed a sensibility in the region of the neck under the angle of the lower jaw, and the patient states that when she turns her head towards the healthy right side, and the soft parts of the left side of the neck become tense, the pains in the left parietal region become worse. The left carotis is thicker and harder and pulsates more strongly. Its pulsation is externally visible on the thin neck, which is not the case on the right side.

In this case, which was greatly relieved by galvanization of the cervical sympathetic, the symptoms pointing to the subparalytic affection of this nerve were so little marked, and at times so slightly manifest, that they would hardly have been noticed, had not our attention been sharpened by former observations.

Yet a fourth case, which happened some months ago, may be

briefly mentioned, in order to indicate still another kind of appearance of the affection.

A lady, Mrs. F., from E., aged 47, suffers since two years from attacks of megrim-like headache of the right side, generally lasting from evening to evening. At the same time the right cheek becomes hotter and redder, the eye pains, and the patient feels as if it were drawn out of the orbit. The patient was examined during a painless interval, and no difference was found in the injection and temperature of the two sides of the face; but there existed a very striking difference in the width of the two pupils, the right being considerably narrower than the left, and the mobility of both well preserved. Furthermore, the right palpebral fissure was a trifle lower than the left, and, finally, the tension of the right eye was somewhat less than that of the left. Both eyes were a little amblyopic, but the right, which is said to have been formerly as good as the left, renders now less service, especially in close proximity, and does not read the finest print as well. There was no opportunity of determining the far point by the instillation of atropia. Without doubt the symptoms are much more pronounced during the attacks of megrim.

If these last four cases be compared with the thoroughly analogous consequences, observed in injuries of the cervical portion of the sympathetic, or in pressure exerted upon the latter in cases of tumors, abscesses, and the like, no doubt can remain as regards their significance. In *Eulenburg* and *Guthmann's* paper, in the "Archiv für Psychiatrie," concerning the pathology of the sympathetic, the greater part of the hitherto acquired experience is collected with all detail and completeness. We can here refer to the description, given in this article, of the symptoms of paralysis as well as of those of irritation of the cervical sympathetic.

So far as we know, we find in literature but exceedingly little information as regards the conditions described in the last four cases. Such cases are by no means rare, as we observed four of them in as many months. The only accurate observation of the group of the above-mentioned symptoms has been made by *Horner*.* It was the case of a middle-aged woman, in whom the half-sided vasomotory disturbances returned periodically in a very

* Klin. Monatsbl., 1869, p. 193. (The dissertation of *Nicati*, La paralysie du nerf sympathique cervical, Lausanne, 1873, written under the direction of *Horner*, had not appeared at the time the above was written. Vide, concerning the same, *Nagel's* Annual Report for 1873, page 288.)

decided manner, and, as it seems, without neuralgic pains. In connection with this group of cases, we may refer to an observation, reported three years ago by *John Roosa*, at the American Ophthalmological Society, and about which references are made in *Nagel's* Ophth. Annual Report for 1870, page 271.

In the case of a young girl, 18 years old, there appeared, during a period of nine months, and with great regularity, weekly attacks of injection of one eye, with violent pain, contraction, and sluggishness of the pupil, lachrymation, and a slight decrease of tension of the globe. The upper lid was somewhat sunken, and remained so between the attacks. With this imperfect ptosis the whole affection had commenced. The injection was limited to the conjunctiva bulbi, and especially its nasal portions, increasing towards the limbus; the vessels encroached upon the borders of the cornea, but blisters and phlyctænulæ were nowhere visible. Now and then a slight dimness of the cornea is said to have occurred, but only after applications of warm poultices. The severe injection and pain always subsided after a few hours, and the whole attack had disappeared after two days, but only to return again at the end of the week upon that certain day. The attacks were often preceded by sneezing, which is said to have been confined to the affected side. With one of the first attacks a chill also appeared (a noteworthy sign of the excitation of the general vasomotory centre).

Local and general treatment availed little, and quinine and arsenic especially proved useless. Only atropine mitigated the pain, and seemed above all to lessen the duration and intensity of the attack. After a duration of nine months the attacks became rarer and more irregular, and at last ceased; the ptosis also disappeared. The other eye had remained healthy during the whole time.

Roosa considers the case neither as phlyctænular or marginal keratitis, nor as intermittent ophthalmia caused by malaria, but regards it as peculiar, without expressing a definite view as to the nature of its peculiarity. Supported by our observations, we are justified in considering the affection as a vasomotory neurosis of the sympathetic.

Another interesting case is reported by *Albutt*.* In consequence of a blow on the neck, the cervical portion of the spinal column became diseased, and paralysis of the arms and legs en-

* Lancet, 1870, page 76.

sued, to which was added, in the last weeks, a narrowing of the palpebral fissure and of the pupil, conjunctival injection, and congestive redness of the cheek and ear, with elevation of temperature. No doubt the disease had affected the fibres of the sympathetic either in its cervical portion or in its spinal continuation.

And, finally, a case, wonderful in many respects, may be quite briefly mentioned. It is a case which Professor *Nagel* intends to publish in all its details. Hypotony of the eye appeared in co nection with a very peculiar group of nervous symptoms, especially steno-cardiac attacks, the origin of which is mostly ascribed to the sympathetic. During an attack of angina pectoris, both eyes showed a distinct decrease of tension, which disappeared with the attack. The functions of the eyes were disturbed, and, in connection with spasm of accommodation, there existed a concentric limitation of the field of vision, a transient disturbance of the color-perception, manifested by an inability to distinguish green, and all this without any material changes.

The present treatise was written in the summer of 1873, during which Dr. *Schliephake* acted as assistant in my clinic. The intended continuation was interrupted by the departure of the author. The treatise, continued below, by Dr. *Heimann*, the present assistant at the Eye Clinic, furnishes some supplements. In the meantime I have communicated several general facts concerning the vasomotory and secretory neurosis of the eye at the Heidelberg Convention of 1873. (Klin. Monatsbl. für Augenheilkunde, XI., page 394–407), and have particularly referred to the present paper as regards the single observations.

Concerning the physiological explanation of the causation of hypotony by nerve influence, several references are found in the address delivered by Professor *Nagel* at Heidelberg. (Vide Klin. Monatbl. f. Augenheilkunde, 1873, page 394–407.)

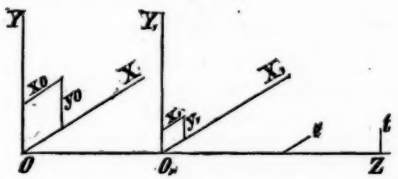
ON THE ANALYTICAL CONDITIONS OF THAT FORM OF ASTIGMATIC PENCIL IN WHICH THE TWO FOCAL LINES ARE PERPENDICULAR EACH TO THE AXIS OF THE PENCIL AND ALSO TO EACH OTHER, AND ON THE CORRECTION OF SUCH PENCIL BY A PLANO-CYLINDRICAL LENS.

By G. HAY, M.D.

It has already been shown in these Archives, Vol. II., No. 1, after the method given by *Knapp* (A. f. O., VIII., 2), that the pencil will have the properties mentioned in the heading of this article, if we suppose the rays situated each according to a certain law; this law being included as a special case in the more general conditions used by *Knapp;* which latter conditions allow of other forms in which the focal lines, though at right angles to the axis of the pencil, are not so to each other.

The following statement of the subject, though in part a repetition, is offered as being more direct in presenting the form of the pencil, and more complete in explaining the corrective action of the plano-cylindrical lens.

Fig. 1.



Consider the position of any ray as referred, according to the method of analytical geometry, to three rectangular co-ordinate axes OX, OY, OZ (see Fig. 1); the last being also the axis of the pencil.

Let x_0, y_0, z_0 be the co-ordinates of the point in which this ray intersects the co-ordinate plane XY.

Let x_1, y_1, z_1 be the co-ordinates of the point in which the same ray intersects the plane x_1, O_1, y_1, parallel to the co-ordinate plane xy and at a distance $z_1 (= 1)$ from it.

Let x, y, z be the co-ordinates of any other point of the line.

We then have for any straight line,

$$\frac{x - x_1}{z - z_1} = \frac{x_1 - x_0}{z_1 - z_0} \quad . \quad . \quad . \quad [1]$$

and

$$\frac{y - y_1}{z - z_1} = \frac{y_1 - y_0}{z_1 - z_0} \quad . \quad . \quad . \quad [2]$$

If we put $z_1 = 1$

and $z_0 = 0$,

then [1] and [2] may become respectively,

$$x = z(x_1 - x_0) + x_0 \quad . \quad . \quad . \quad [3]$$

$$y = z(y_1 - y_0) + y_0 \quad . \quad . \quad . \quad [4]$$

As [3] and [4] apply to each of any cluster of rays, we cannot from them alone deduce any definite form for the cluster without introducing some special conditions.

This may be done by supposing, as in the method of *Knapp*, x_1 and y_1 each to depend on x_0 and y_0, but in a more simple relation than the one used by *Knapp*, thus: suppose, A and D being each constant for the particular pencil,

$$x_1 = A x_0 \quad . \quad . \quad . \quad . \quad [5]$$

$$y_1 = D y_0 \quad . \quad . \quad . \quad . \quad [6]$$

These equations involve, among other things, the condition that rays intersecting the co-ordinate axis OX remain in the co-ordinate plane XOZ; and also the corresponding relation for OY.

Let the planes YOZ and XOZ be called the two principal planes with reference to the pencil subject to the conditions of equations [5] and [6].

Introducing these conditions into [3] and [4], they become

$$x = [\,z\,(A - 1) + 1\,]\,x_0 \quad . \quad . \quad [7]$$

and

$$y = [\,z\,(D - 1) + 1\,]\,y_0 \quad . \quad . \quad [8]$$

These equations [7] and [8], each of which holds for any point of any ray of the specially conditioned pencil, show for certain values of z the characteristic properties of the particular form of astigmatic pencil which we are considering.

Thus according to [7], if $z = z' = -\frac{1}{A-1}$, then $x = o$; that is, in each ray there is a point with the co-ordinates.

z'

x equal to zero,

and the corresponding value of y;

The locus of these points of the different rays is a straight line in the co-ordinate plane YOZ and perpendicular to OZ, which it intersects at distance z' from the origin; or each ray of the pencil intersects this focal line.

Again: According to [8], if $z = z'' = -\frac{1}{D-1}$, then $y = o$; that is, in each ray, there is a point with the co-ordinates,

z''

y equal to zero,

and the corresponding value of x;

The locus of these points is a straight line in the co-ordinate plane XOZ, and perpendicular to OZ and intersecting OZ at the distance z'' from the origin; or, in other words, each ray of the pencil intersects this focal line.

It may be noted here that each focal line being in one principal plane and perpendicular to the other must pass through the focus of the rays in this other plane, as otherwise these latter rays could not all intersect this focal line.

The corrective action of a cylindrical lens on a pencil of such form as we have been considering, a form which we have elsewhere ventured to call the typical form, may be shown according

to *Hoorweg's* method of studying the action of such a lens (see A. f. O., XIX., 2).

Suppose such a typical form as indicated in Fig. 1, in which l and t may represent the two focal lines. Change the origin of co-ordinates from O to O_1. Let the new co-ordinate axes be respectively parallel to the old ones. Suppose a plano-convex-cyl. lens placed with its middle at O_1, and with its plane surface perpendicular to OZ and its cyl. axis parallel to OY.

Consider the co-ordinates x_0, y_0, of the point in which a given ray before refraction by the cyl. lens intersects the plane XY, and also the co-ordinates x_1, y_1, of the point in which the same ray intersects the plane X_1 Y_1, or meets the lens, the thickness of which is neglected in the calculation.

By *Hoorweg's* method it may be shown (see appendix below) that each refracted ray, if continued backwards, would pass respectively through a certain point R, different for the different rays, in the plane XY, and that the co-ordinates x_2, y_2, of the point R are such, the ratio of x_2 to x_1 being constant for all the rays, and the ratio of y_2 to y_1 being constant for all the rays, that the refracted pencil is still of the typical form (see equs. [5] and [6] above), and with its focal lines respectively parallel to those of the pencil before refraction.

Now, remembering that each focal line is in one of the principal planes and perpendicular to the other, and passes through the focus of the rays in this other, we can evidently select the cylindrical lens, placed as mentioned above, of such power, that the focus of the rays in one principal plane will be at the same point of the axis of the pencil as the focus of the rays in the other principal plane, and that therefore the two focal lines would have to intersect each other at this same point; and therefore we may say that each ray of the pencil having to intersect each of the two focal lines must pass through the point of their intersection, and so the pencil become homocentric.

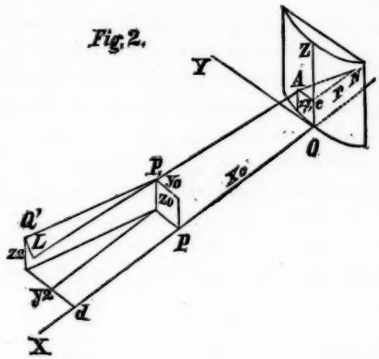
Appendix to the preceding.

To show that a typical astigmatic pencil, after passing through a plano-cylindrical lens placed in a certain position with reference to the pencil, is still of the typical form.

In the diagrams below, Figs. 2 and 3, to illustrate this, the

lettering is different from that of Fig. 1 above, for the sake of easy reference to Hoorweg's diagrams, from which Figs. 2 and 3 are mainly derived, with slight modifications, to correspond to the present problem.

Fig. 2.



In Fig. 2, OX, OY, OZ represent the three rectang. co-ord. axes. OX represents also the axis of the pencil, and is perpendicular to the plane surface of the lens. OZ lies in the cyl. surface of the lens, along its thickest part (in the case of a plano-convex), and is parallel to the geometrical axis of the cyl. surface.

We suppose a typical astigmatic pencil, whose axis is PO (see Fig. 2), the light proceeding in the direction from P to O. We wish to find the condition of the pencil after passing through the lens. Let P_1A be one of its rays; P_1 being the point in which this ray intersects the plane P_1P, which is perpendic. to XO at P, and A being the intersection of the given ray with the plane YZ, this last point being considered approximatively the same as the intersection of the ray with the ant. surface of the lens. Denote the co-ordinates of P_1 by x_0 (= PO), y_0 and z_0, and those of A by x_1 (equal to zero), y_1 and z_1. We then have, in accordance with the supposition* of equs. [5] and [6] above, and using the notation of Fig. 2,

$$y_0 = a y_1 \quad . \quad . \quad . \quad . \quad [9]$$

* And also as a consequence of the typical form of the pencil.

and $$z_0 = bz_1 \quad . \quad . \quad . \quad . \quad [10]$$

a and b being each constant for all the rays.

We have to find the point Q′ such that Q′A is the direction of the refracted ray as it proceeds from A into the lens. Continue AP_1 to L, taking $AL = n.AP_1$; draw through P_1 the line P_1Q' parallel to the normal AN to the cyl. surface at A, then in plane LP_1Q' describe about A with radius AL an arc; the intersection of this arc with P_1Q', that is, Q′ is the point desired. The correctness of the construction appears from the consideration that Q′A lies in the plane $Q'AP_1$ in which lie the incident ray and the normal at the point of incidence to the surface at which refraction takes place, and also that $\sin.Q'P_1L = n \sin.AQ'P_1$.

To find the co-ordinates of Q′, which may be denoted by x_2, y_2, z_2.

As $Q'P_1$ is parallel to AN, which is parallel to the plane YOX, therefore

$$z_2 = z_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [11]$$

As angle of P_1A with PO is supposed small, and as A is near to O, therefore angle of Q′A with PO is also small; also, A may be considered as approximatively in plane YZ; we have

$x_2 = dO =$ approx. Q′A

$Q'A = LA = nP_1A$

$P_1A =$ approx. PO

$PO = x_0$

therefore,

$$x_2 = nx_0 \text{ (approx.)} \quad . \quad . \quad . \quad . \quad . \quad [12]$$

To get y_2, we have, subject to certain approximations, by comparison of similar triangles indicated in Fig 2, in which the plane AcN is perpendicular to OZ at c, N is in the geometrical axis of the cylindrical surface, and $cN = r =$ the radius of the cylinder,

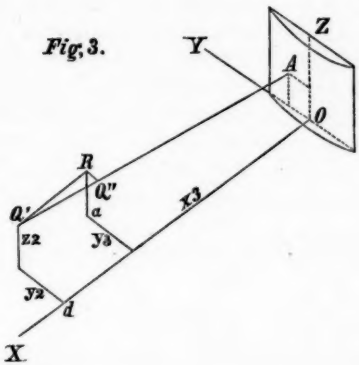
$$y_2 - y_0 : (n-1)\, x_0 = y_1 : r$$

$$y_2 = y_0 + \frac{(n-1)\, x_0 y_1}{r} \quad . \quad . \quad . \quad . \quad . \quad [13]$$

We have next to consider the second refraction of the ray in

passing through the plane surface into the air; and for this purpose consider the ray in the lens as if having emanated from the point Q′ and meeting the plane surface at a point, which by way of approximation, neglecting the thickness of the lens, we will assume to be the same as A.

Fig. 3.



We have then, by a method similar to that just used to find a point R (see Fig. 3), such that RA will be the direction of the ray as it proceeds from the point A into the air after the second refraction. Denote the co-ordinates of the point R by x_3, y_3, z_3.

To find R, draw through Q′ (see Fig. 3), a line Q′R parallel with the normal to the plane surface of the lens, that is, parallel with OX. Take on the line Q′A the point Q″ such that $Q'A = nQ''A$. Then in plane RQ′A draw about A with radius AQ″ the arc Q″R; where this arc intersects Q′R, namely, at R, is the point sought; for RA lies in the plane of the incident ray, and of the normal at the point of incidence upon the surface at which refraction takes place; and also $\sin.Q'RA = n \sin.RQ'A$.

As Q′R is parallel to XO, we have

$$z_3 = z_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [14]$$

$$y_3 = y_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [15]$$

As Q′A makes a small angle with XO, RA also makes a small angle with XO. We have

x_2 = approx. RA

$$RA = Q''A = \frac{1}{n} Q'A$$

$$Q'A = \text{approx. } x_1$$

Therefore

$$x_2 = \text{approx. } \frac{1}{n} x_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad [16]$$

Substituting in [14], [16], and [15] the values of z_2, x_2, and y_2 obtained respectively from [11], [12], and [13], we get

$$z_2 = z_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [17]$$

$$x_2 = x_0 \text{ (approximatively)} \quad . \quad . \quad . \quad . \quad . \quad . \quad [18]$$

$$y_2 = y_0 + \frac{(n-1)\, x_0 y_1}{r} \text{ approximatively} \quad . \quad . \quad [19]$$

and thus, by substituting in [17] and [19] the values of z_0 and y_0 obtained respectively from [10] and [9], we get, subject to the approximation referred to,

$$z_2 = bz_1$$

$$y_2 = \left[a + \frac{(n-1)\, x_0}{r} \right] y_1$$

That is, R being the intersection of any ray of the new pencil with the plane P_1P, and A being the intersection of the same ray with the plane AOZ (see Figs. 2 and 3), we have, for all the rays of the new pencil, that the z-co-ordinate of R is in a constant ratio to the z-co-ordinate of A, and that the y-co-ordinate of R is in a constant ratio to the y-co-ordinate of A. These are conditions, which we have seen above (see [5] and [6]), necessitate the typical form of the pencil, and the focal lines of the pencil after refraction by the cyl. lens will be respectively parallel to those of the pencil before refraction (except where the two focal lines have come together and each is reduced to a point).

ASTIGMATISM. — THE FUNDUS OF ASTIGMATIC EYES.—AN ATTACHMENT TO THE OPHTHALMOSCOPE.

By WM. S. DENNETT, M.D., Boston, Mass.

Ophthalmic Surgeon to the Boston Dispensary.

It has been in the way of the writer, within the last two years, to examine the vision, refraction, and accommodation of a considerable number of patients, embracing from one to two thousand cases of diseases of the percipient apparatus and anomalies of the refractive media.

During this time attention was occasionally called to the danger of mistaking certain appearances of the fundus, due to astigmatism, for conditions which may co-exist with and be caused by that trouble, but which are sometimes only simulated by it.

The nerve of an astigmatic eye does not always look oval, and, on the other hand, a nerve seen through normal refractive media sometimes does. The uneven curvature of an astigmatic cornea, by magnifying certain parts of veins and arteries in the fundus and diminishing the apparent size in other parts, may well give rise to the appearance of congestion, either active or passive; and the general indistinctness of outline, which in some cases pervades the whole fundus, is not easily distinguished from an œdematous state of retina and nerve.

I have notes of a case in which the patient was supposed to have a hyperæmic and œdematous nerve and retina. Vision was about one-half as good as it should be, and the ordinary spherical glasses did not improve it. Nothing in the case pointed especially to astigmatism, and no examination for that trouble was made; the congestion of the fundus being thought sufficient to account for the lack of vision.

After a few weeks' treatment with iodide of potassium, etc., etc., little or no improvement being brought about, an examination showed astigmatism of 1.5 dioptrics in each eye, and vision

fully up to the standard in the right eye and very nearly so in the left, with a cylindrical glass (1.5) behind the mirror of Jäger's ophthalmoscope. The fundus looked healthy enough. The patient bought the glasses as ordered, and was well satisfied with the result.

There is no reason why the fundus of an astigmatic eye should not be seen as distinctly as that eye can be made to see, and the average improvement of cylindrical over spherical glasses is considerable.

I have at hand an instrument made to fasten to the back of Loring's ophthalmoscope for the purpose of correcting existing astigmatism, whether in the eye of the patient or caused by the unavoidable inclination of the spherical glass used in the ophthalmoscope.

It takes advantage of the principle brought to the notice of the American Ophthalmological Society by Dr. Hay, at their yearly meeting in July, 1875, viz., that the focal strength of a plano-cylindrical glass is increased by rotating it on its axis, so as to lessen the angle that its plane surface makes with the line of vision.

The instrument consists of two discs nearly 5 millimetres apart, perforated in their centres, and placed directly behind the aperture of the mirror. This central space is about 6 or 7 millimetres in diameter, and in it is fixed a cylindrical 5 or 1.5, as the case requires. The discs, one or both of them, are turned by the same finger that manipulates the Rekoss disc, and with equal ease.

Turning both discs changes the inclination of the axis of the cylindrical glass; turning one disc revolves the cylindrical lens about its stationary axis.

Whichever of the four glasses are used, a scale on the back of the outer disc gives its inclination to within one-half minute, and also shows the number of the cylindrical glass to which it is equivalent at any given position.

Any one in the habit of using the upright image will have no difficulty after the first sitting, if at all, in using the instrument whenever occasion requires, and manipulating the glasses, both spherical and cylindrical, while looking through them.

The instrument can be used to determine the amount of astig-

matism, by turning the discs, while examining, to the position in which the best view of the fundus is obtained, and then reading the result on the back.

The appliance is not yet old enough to have had a fair trial. It was first used by a very accomplished ophthalmoscopist in the examination of an eye that was astigmatic only 1. dioptric, and had normal vision, and it gave a decidedly better view of the fundus than the ophthalmoscope alone, either Loring's or Jäger's. On one occasion I myself was able to see the macula with it, and not without it.

Its disadvantages are—*First:* It slightly narrows the field, especially in cases that require a considerable inclination of the cylindrical glass; though the whole nerve, and something more, may always be seen at once. *Secondly:* It is sometimes necessary to change the cylindrical lens, two at least being required to cover the whole ground satisfactorily.

Thirdly: The ophthalmoscope must be held four or five millimetres farther from the eye of the observer with the attachment than without it.

All these disadvantages can probably be remedied by making the two discs a little nearer together, and replacing the separate cylindrical lens by a single Stokes's lens of larger diameter.

The Stokes's lens can be made equivalent to any simple cylindrical by turning the disc of spherical glasses until there is before it a spherical glass of just one-half the strength of the lens required.

The average improvement of the ophthalmoscopic picture to be expected from an instrument like the above may be in some measure estimated by the improvement in vision which the patient generally gets from cylindrical glasses. This in all the cases on which I myself have been able to obtain full notes—twenty-five in number, comprising forty-nine eyes—has averaged one hundred and thirty-six per cent. These cases include all eyes in which the astigmatism amounted to .75 dioptrics or more. If an easily managed instrument is capable of doing as much for the eye of the ophthalmoscopist, no accomplished ophthalmoscopist will be without it.

A CASE OF MYXOMA OF THE OPTIC NERVE. REMOVAL OF THE GROWTH WITH PRESERVATION OF THE EYEBALL.

By Dr. EMIL GRUENING, of New York.

Von Graefe observed two cases of tumor of the optic nerve, and from the analysis of these cases deduced the special characteristics of such growths.

He mentions particularly that the steadily increasing protrusion takes place in the direction of the axis of the optic nerve, or perhaps a little outwardly; that the mobility of the eyeball, due allowance being made for its displacement, remains unimpaired; that a delicate layer of loose connective tissue intervenes between the tumor and the globe of the eye; that the affection runs a painless course; that the tumor is of uniformly soft consistency; that subjective sensations of light do not occur, notwithstanding the early implication of the optic nerve; and, finally, that vision is affected at a far earlier period than is usual in the case of benign tumors of the orbit.

It seems strange that von Graefe, who was aware of the existence of a layer of loose connective tissue between the eyeball and tumor, not only failed to use the weight of his authority in favor of extirpating the tumor while preserving the eyeball, but even, in view of the position of the tumor within the muscular funnel, most absolutely denied the practicability of such a procedure.

So far as I know, Knapp was the first who, in spite of the forcible objections of so weighty an authority as von Graefe, made the deliberate and successful attempt to preserve the eyeball in a case of removal of a tumor connected with the optic nerve.

It is true that, long before Knapp, deep-seated tumors, even such as were situated within the muscular funnel, and perhaps connected with the optic nerve, have been extirpated without removal of the eyeball. In these cases, however, the diagnosis of the presence of a tumor of the optic nerve had not been made

before the operation, and the removal of a portion of the optic nerve was purely accidental, and as foreign to the plan of the operation as startling to the operator.

I had quite recently an opportunity of testing the practicability of Knapp's operation in a case of tumor of the optic nerve:

Miss Anna Lorenz, 34 years of age, of healthy appearance, presented herself, in the summer of 1875, at the New York Ophthalmic and Aural Institute, suffering with a left exophthalmos of high degree. She stated that in 1861 she had fallen down a flight of stairs and slightly injured the left side of her head. Two years later, while accidentally covering her right eye, she noticed that the left eye was almost totally blind, and had but slight quantitative perception of light.

In 1867, six years after the fall, she discovered a slight protrusion of the left eye. From that time on, the protrusion gradually but steadily increased. The quantitative perception of light became extinct. She began to suffer from very intense pain, which radiated from the back of the orbit to the parts surrounding the eye.

Upon examination, I found the left eye protruding in the direction of the optic axis. The protrusion measured about six lines. The mobility of the eye was as well preserved as its position would allow. The upper lid was distended in proportion to the degree of protrusion; and closure of the palpebral fissure was easily effected. At times, when the patient rubbed her eye, the lids were caught behind the equator of the globe and the whole eyeball was exposed. By palpation I detected a retro-ocular mass of soft consistency and smooth surface. Pressure upon the globe did not effect any reduction of the exophthalmos. The ophthalmoscope showed transparent refractive media, a white atrophic disc, narrow retinal arteries, moderately sized retinal veins, and a uniformly orange-colored background.

Consideration of the combination of these signs, together with the history of the case, led me to diagnosticate a tumor of the optic nerve, and in view of the fact that the tumor had grown very slowly, while the health of the patient had not become impaired, I inferred the benign character of the growth.

The patient was anxious to be relieved of the intense orbital pain and great disfigurement, and urged me to remove the eye, and thus render possible the wearing of an artificial eye. I informed the patient that the tumor could probably be removed without sacrificing the eye.

The operation was performed at the Ophthalmic and Aural Institute, on October 5th, 1875, in the presence, and with the kind assistance of

Drs. Knapp, Pooley, Aub, Sattler, and others. The patient was completely etherized. After separating the lids by means of a wire speculum, I incised the conjunctiva at the distance of 4''' from the limbus corneæ between the rectus internus and rectus inferior, opened Tenon's capsule, and pushed the scissors along the globe to its posterior pole. I then enlarged the wound towards the nasal side, cutting through the semi-lunar fold and the caruncle, and thus gaining space for the introduction of the index finger of the left hand. I felt a soft and elastic growth of the size of a hazelnut occupying the anterior portions of the optic nerve. Guided by the finger, with one stroke of the scissors I cut through the tumor at its point of contact with the globe, which then slipped through the conjunctival opening, executing a rotation of about 180° around its vertical axis, and presenting to view the cut end of the optic nerve.

The gentlemen present convinced themselves by ocular inspection that the nerve had really been severed. The slipping of the eyeball had been greatly facilitated by an unintentional cut through the rectus internus muscle. The reduction of the globe was effected with ease, but in the course of the operation it performed the above-mentioned revolution a number of times. The cutting of the tumor was followed by profuse hemorrhage, which was readily checked. The tumor itself, after its separation from the eyeball, collapsed and fell into the orbital cavity. Owing to its soft consistency, the tumor was not readily distinguishable from the normal contents of the orbit, and the repeated introduction of a toothed forceps was necessary in order to seize it. In the attempt to draw the tumor forward, the soft mass yielded, and I was obliged to cut it out piecemeal. A few lobules of orbital fat were accidentally brought away in the teeth of the forceps.

On exploring the cavity of the orbit with the finger, no remnants of the tumor could be detected, and the operation was therefore considered completed. In order to prevent any further slipping of the eye, I applied a suture, closing the conjunctival wound.

On ophthalmoscopic examination, immediately after the operation, I discovered no changes in the background of the eye. The central retinal vessels were then as much filled as before. The pupil, which had reacted promptly before the operation, was now immovable. The inner half of the cornea and the adjoining conjunctiva were anæsthetic. The tension seemed somewhat reduced, perhaps—$T_{,}$. The eyeball was absolutely immovable, and protruded considerably. By pressure no reduction of the exophthalmos could be effected.

In regard to the subsequent course of the case, I may state that the healing of the wound proceeded rapidly and without much inflammatory reaction.

A few days after the operation the cornea became hazy, but soon cleared up. In ten days the globe had receded into the orbit, and every trace of exophthalmos had disappeared. The circulation within the retinal vessels was at no time interrupted. Tn. I examined the eye a few days ago (September 1, 1876), and noted the following conditions: The eye occupies the primary position. Its motility is limited in all directions. The left eye is somewhat more deeply set in the orbit than the right. The inner half of the cornea and the adjoining conjunctival region are still anæsthetic. At its inner and lower quadrant the iris is atrophic, discolored, and adherent to the lens capsule. (The synechia developed gradually, and without manifest inflammatory symptoms.) The papilla of the optic nerve is perfectly white and its outline distinct. The retinal vessels are well filled, and pulsate when slight pressure is made on the eyeball. The veins cannot be distinguished from the arteries. Several vessels are broad at the periphery, but narrow and pointed at the papilla. The choroid is decidedly atrophic, but more especially its nasal half. The retina contains many irregular pigment patches, which are most densely crowded at the peripheral portions, and more pronounced on the nasal than on the temporal side.

The several pieces of the removed tumor, when put together, amounted to nearly the size of a filbert, and presented in fresh sections a whitish-red appearance. After three weeks' hardening in Müller's fluid, the growth was examined with the microscope, and found to be a pure myxoma. Transverse sections showed a tolerably regular arrangement of alveoli of nearly uniform size enclosed in a delicate framework of connective tissue. The alveoli were filled with a hyaline substance, in which were imbedded a small number of stellate cells. The centre of the sections and the connective-tissue septa contained numerous blood-vessels. The most thorough search failed to discover nerve fibres, and nothing but the arrangement of the septa of connective tissue suggested the structure of the optic nerve.

In his symptomatology of optic nerve tumors, based on the observation of two cases, Graefe mentions as characteristic the painless course of the disorder. In the two cases observed by Knapp and myself, the excessive pain suffered by the patient, and in fact one of the prime motives of their application for relief, shows that painlessness, though an occasional is not a necessary characteristic of this affection.

A symptom not mentioned in cases hitherto described, but observed by me in the case under consideration, was the tendency of the eyeball to slip through the palpebral fissure on the application of pressure downward and backward upon the upper lid. At times, when the patient, in order to relieve irritation, rubbed her eye, she found to her great discomfiture that the eyeball thus protruded, was pressed forward and held firmly in position by the spasmodic closure of the lids behind the equatorial region of the eyeball.

In my operation I varied from the method followed by Knapp, in making my incision not between the rectus internus and rectus superior, but between the rectus internus and rectus inferior, in order to afford a readier escape for the collecting pus.

In regard to the condition of the retina after the operation, my own observation has shown a markedly different result from Knapp's. "Three days after the operation," he writes, "the retina was seen like a uniformly white, milky surface; no optic disc, no blood-vessels were discernible. On the fourth day, two short, dark red streaks made their appearance. They became thicker and longer, and were successively accompanied by a great many others, until, two weeks later, the complete system of retinal vessels, arteries and veins, was filled with blood again."

In my case the immediate result of the operation was to leave the apparent condition of the retina, the optic disc, and the retinal blood-vessels essentially the same after the section of the nerve as before. The only change immediately perceptible was the disappearance of any visible distinction between the retinal arteries and veins, the former assuming the darker hue peculiar to the latter, but without any manifest interruption of the circulation.

NOTE TO THE CASE OF VASCULAR PROTRUSION OF BOTH EYEBALLS, ARISING FROM INTRACRANIAL ANEURISMAL VARIX.

By Dr. EMIL GRUENING.

(With Plate X.)

In Number 1 of this volume of the Archives I published a case of vascular protrusion of both eyeballs, arising from intracranial aneurismal varix, and perfectly cured by ligation of the left common carotid. A very accurate drawing of the condition of the patient, both before and after the operation, has been prepared by Mr. Albert H. Fridenberg, a student at the College of Physicians and Surgeons of this city. The drawing, lithographed in Germany, arrived too late for the first number of this volume, and is, therefore, now supplied.

In this connection I may mention that at the date of writing, twenty months after the operation, the patient, Mrs. Susan Canterbury, is still doing as well as at the time of the original publication of my report. Her general health is good, and the state of the functions of sight and hearing has remained unaltered. No cerebral symptoms have supervened.

I desire to make the following correction in the printed report of the case:

For "common," Vol. V., Part I., page 46, lines 9 and 16, read "internal."

ON THE OPERATIVE TREATMENT OF VASCULAR TUMORS OF THE EYELIDS AND ANTERIOR PART OF THE ORBIT.

By H. KNAPP.

THERE seems to be, among the profession, a certain dread of attacking vascular tumors with the knife. It is true, *J. F. Dieffenbach*,* after having discussed ten other modes of treatment, states: "The extirpation of vascular tumors with the knife and union of the edges of the wound with pins and twistes sutures is, of all methods, the best. I employ it almost exclusively, if the treatment with liquor plumbi or alum, in combination with compression, fails to effect a cure." On the other hand, *McKenzie*† says: "Nævi and anastomotic aneurisms have been removed by excision. This is an effectual, but by no means a very safe mode of cure." I shall not here consider the advantages and disadvantages of caustics, galvano-cautery, ligature, and other modes of treatment. I only want to state that extirpation has given me the most satisfactory results, and that none of the operations I have performed were accompanied or followed by uncontrollable or excessive hemorrhage. There is in modern ophthalmic literature‡ a limited number of cases on record in which vascular tumors were removed from the depth of the orbit with or without preservation of the eyeball. With these deep-seated and rare angiomata I shall not at present occupy myself, but simply describe, from a clinical stand-point, what my personal experience has taught me concerning the vascular tumors in the anterior part of the orbit and the eyelids. Though such tumors are not in-

* Operative Chirurgie, Vol. I., p. 241. 1845.

† Textbook, p. 168. London, 1866.

‡ *A. von Graefe:* Arch. f. Ophthalm., Vol. VII., No. 2, p. 11, etc. Berlin, 1860.
L. Wecker: Gaz. Hebdom., No. 47. Nov. 22, 1867.
Manz: Mon.-Bl. f. Augenhlk., VI., p. 182. 1868.
Holmes: Chicago Med. Journal, Vol. XXVII., p. 1. Jan., 1871.
Horner: Mon.-Bl. f. Augenhlk., IX., p. 18. 1871.

frequent, and are of great practical importance, they do not seem to have received from authors their due share of attention. In some textbooks they are hardly mentioned, and even *Prof. F. Arlt's* excellent treatise of the operations on the eye in Graefe-Saemisch's Cyclopædia of Ophthalmology* says only "that their size and locality determine the choice of the operative method, according to general principles."

The great majority of vascular tumors occur in children, increase steadily to a certain extent, and in their growth involve the adjacent healthy tissues. When located in the eyelids or orbit, their importance is far greater than when located in other parts of the body; for, if left alone, their weight interferes with the movements of the lids, and, if operated on too late or inappropriately, great defects and deformities of the lids are the consequence. In both cases the eye is either useless from being closed, or endangered from being exposed. The surgeon cannot, therefore, be too careful in dealing with these tumors.

The paramount principle in treating them is to *preserve to the eyelids their integrity of form and movement.* Application of astringent remedies and compression are unavailable, since the underlying parts are not hard enough to make compression efficient. The ligature will not, in most cases, comprise the whole extent of the tumor, and if it do well enough for tumors in the vicinity of the lids, it can, I think, hardly be applied to just those cases which we here consider. Destruction of nævi by caustics and the galvano-cautery, as far as I have seen, is apt to produce greater defects and deformities than result from judicious extirpation, which can be limited with greater precision to the exact boundaries of the diseased structure. Why, then, is extirpation not generally resorted to? Because surgeons are afraid of the *hemorrhage* connected with it; and this fear is not without foundation, since excessive and even fatal hemorrhage has been observed to accompany or follow such operations. If this accident, even in the smallest percentage of cases, could not be obviated, the extirpation of vascular growths should never be attempted. The object of the following remarks, all of which are the result, not of speculation, but of actual and personal

* Vol. III., p. 479. Leipzic, 1874.

experience, is to show how hemorrhage, in removing tumors from the locality under consideration, can either be obviated or controlled, and the patient may with safety receive the advantages which the extirpation has over every other method of treatment.

In describing the operative procedures, I shall, for practical reasons, make the following subdivisions:

1. *Cutaneous or subcutaneous nævi of the eyelids not involving the cartilage and orbit.* Their extirpation can be made easy and even bloodless by the assistance of *Desmarres's* palpebral clamp forceps or some one of its modifications. By way of illustration, I will relate the following case out of many similar ones:

On 10th February, 1876, a child of one year and a half was brought to the clinic of the N. Y. Ophthalmic and Aural Institute, with a red, soft, compressible tumor the size of a small French bean, occupying almost the entire outer surface of the left upper eyelid. It extended to the ciliary edge, but not to the intermarginal space, nor to the inner surface of the lid. It had been noticed as a small pimple soon after birth, and had steadily increased. Besides the tumor which caused the eyelid to droop, there was no other abnormity.

I applied my own clamp forceps, so as to comprise the whole tumor and the adjacent skin within the ring and have it well exposed and raised upon the hornplate. Then I made a section through the skin parallel to the edge of the lid, and, after the first drops of blood had been wiped off, the whole tumor was removed without another drop of blood. It presented itself as a soft, slightly nodular pale-red mass, clearly distinguished from the surrounding tissue. Its connections with the cartilage were very intimate, and it required some care and delicate dissecting to cleanse the cartilage of all the nodular tissue upon it. This could, however, be done with the greatest precision, since the absence of bleeding made it easy to recognize the least particle of morbid substance. The cartilage then presented a perfectly clean and white surface, which was denuded in its whole extent. After the withdrawal of the clamp, there was not even so much bleeding as from an ordinary fibrous tarsal tumor. The wound, which was closed by a few sutures, healed by suppuration and granulation, without leaving a scar. The lid had the same shape and mobility as the other upper lid, and no difference between the two palpebral fissures was perceptible.

The tumor had partially a cavernous, partially an angiectatic character.

The use of the clamp is of the greatest service in these operations, and I am of opinion, certainly in concurrence with the majority of modern oculists, that no other mode of treatment should be resorted to.

2. *Cutaneous or subcutaneous nævi involving the free edge and tarsal cartilage of the lid.* These tumors are less pleasant to deal with than the preceding. A total removal by the knife or a total destruction by any other method could not but leave a defect in the lid often combined with eversion and its injurious consequences. This condition would necessitate a plastic operation, by which it might be more or less satisfactorily improved. I have, in some such cases, operated exactly as in the first group, *i. e.*, by removing only the epitarsal part of the growth, leaving the edge of the lid and the cartilage intact, and had the gratification of seeing the prolongations of the nævi in the cartilage shrink and completely disappear. I think this may be looked for in all cases where the blood supply of the growth is furnished by epitarsal vessels, which, in the excision of the tumor, are all divided. One of these operations was followed by repeated copious hemorrhage, and I will therefore relate it as an instructive example.

Three years ago, a child of about four months was brought to me with a vividly red, soft, elastic, moderately prominent tumor occupying the outer half of the left upper eyelid, and extending to the intermarginal edge and inner surface without being raised over the level of these parts. The epitarsal part of the nævus swelled considerably when the child cried; but its intermarginal and conjunctival surfaces did not swell.

I applied a Snellen's clamp forceps, and removed all the epitarsal part of the tumor that was enclosed in the ring of the instrument.

The extreme temporal portion, not inclosed by the ring, escaped the knife and had to be removed, after the withdrawal of the clamp, with fixing forceps and scissors. The extirpation was followed by considerable hemorrhage, evidently because it was not complete. After the bleeding was arrested, by uniting the edges of the wound with pins and twisted sutures, the child was sent home. In the night the wound bled profusely, and, when I was called early in the morning, I found the child very pale; the bleeding ceased at once by the application of iced compresses. In the afternoon the bleeding recurred, and ice had to be applied again. I then took the child to the Ophthalmic Institute, and, as crying produced another after-hemorrhage, I cauterized the outer end of the wound with nitrate of silver and used Munsol's solution (persulphate

of iron). When the bleeding was arrested, I covered the wound with styptic cotton, over which I placed a compressive bandage. No further hemorrhage ensued. The wound healed by suppuration, the intermarginal and conjunctival fire-mark disappeared, and the operation proved a complete success.

The tumor was chiefly composed of cavernous tissue.

This operation was less clean and neat than subsequent similar ones in which I used my own modification of *Desmarres'* forceps, which affords a greater space of operation, draws the lateral parts more extensively in, raises and stretches the parts to be removed —thereby exposing them better, and arrests the hemorrhage more efficiently than *Snellen's* forceps. In the above operation a portion of the cavernous tissue left upon the outer end of the cartilage had doubtless caused the after-bleeding.

In similar cases I shall proceed in the same manner. Before sacrificing any integral part of the lid, I shall always try the result of a partial extirpation. Pins and twisted sutures, properly applied, can hardly fail to arrest the hemorrhage. When the patient is admitted to an hospital where a surgeon is constantly at hand, after-hemorrhage can be controlled by the application of ice, styptic solutions, and a compressive bandage. Should all this fail, compression of the lid with the clamp forceps is certain to arrest the bleeding.

I have never had an opportunity to try *Dieffenbach's* plan of successive partial extirpations of extensive erectile tumors. In order to avoid too large a denudation of the underlying parts and too extensive a suppurative surface, he cuts out wedge-shaped pieces, which are grasped by a T-shaped or laterally branched forceps (Balkenzange), and arrests the hemorrhage by uniting the edges of the wound with ordinary and twisted sutures, having, previous to the excision, passed pins and armed needles through the tumor underneath the branches of the forceps. When the cicatrization is completed, he removes another piece, and so on, thus gradually diminishing the size of the tumor.* This procedure may, I think, be advantageously adapted also to certain cases of nævi of the lids.

3. *Cutaneous or subcutaneous vascular tumors of the lids, ex-*

* See Dieffenbach's Operative Surgery, Vol. I., page 242, etc.

tending into the orbit, but leaving the tarsus and edges of the lids free.—This group is well exemplified by the following case, which, therefore, I will report more in detail :

In the middle of April, 1873, I was called to see a child a little over two months old. It had a thickening of the inner half of the left upper eyelid, which was slightly blue, and pervaded by a number of dilated and tortuous veins. Only the outer portion of the lid could be moderately raised, which rendered the swelling in the inner portion more conspicuous. When the child cried, or was held so that her head was low, the intumescence grew larger and bluer. On palpation it manifested itself as a circumscribed, slightly uneven tumor, which was soft, yet so resistant that its outlines were distinctly felt. It was located in the inner-upper corner of the orbit, extending from the ligamentum canthi internum along the inner and upper walls of the orbit to nearly the centre of the upper lid. The skin was partially movable over it. The tumor seemed firmly united to the adjacent walls of the orbit. Its posterior portion penetrated farther into the orbit than the exploring finger could reach. Pressure upon the tumor diminished its size, without, however, making it entirely disappear. There was neither pulsation nor bruit on auscultation. The tumor had first been noticed a few weeks after the birth of the child, and had steadily increased ever since. During the three weeks I observed it, it became markedly larger.

I made the diagnosis of a *vascular fibro-lipoma*—the most common kind of orbital tumors in children, so far as my experience goes. An oculist of this city, who had seen the child before I was called, termed the difficulty a nævus, and told the parents to give themselves no uneasiness about it; nothing could be done before the child was a year old. Considering the nature, locality, and growth of the tumor, I advised its extirpation without delay. My opinion was supported by Dr. *Gurdon Buck*, who was called in consultation; and I had the honor to make the operation in conjunction with him, assisted by Drs. *T. R. Pooley* and *C. S. Turnbull*, May 13, 1873. I made a curved incision through the skin, beginning near the ligamentum canthi internum, and following the tracts of the fibres of the orbicular muscle as far as the junction of the middle and outer thirds of the upper lid. As it proved impossible to grasp the tumor between the branches of a clamp lid-forceps, a hornplate, introduced in the conjuntival sac between the eyeball and the upper lid and pressed against the inner wall of the orbit, served both to expose the tumor conveniently, and to obviate copious hemorrhage by compressing the blood-vessels entering from the depth of the orbit into the tumor. A bluish-red mass, the size of a French bean, presented itself under the skin, and could be re-

moved without material difficulties. When the insignificant bleeding, which followed the withdrawal of the hornplate, was arrested, another red tumor became visible at the bottom of the wound. I grasped it with a pair of fixing forceps, and drew it forward as far as possible. Guided by my left index finger, I severed it from its looser surroundings in the orbit with a fine scalpel and a pair of strabismus scissors. I had repeatedly been obliged to take a fresh hold of the tumor, and even to use two forceps simultaneously, in order to arrest the hemorrhage by locking a greater portion of the neoplasm in between the branches of the forceps. After the division of the strings of connective tissue and blood-vessels which came from the orbit and inserted themselves like a pedicle into the tumor, a copious venous hemorrhage ensued, but was readily controlled by compression with the fingers and sponging with cold water. Some tuft-like small portions on the inner wall of the orbit, in particular on the lachrymal sac, that had been overlooked, were now removed, and, when it appeared that no trace of the neoplasm was left, the wound was closed by four simple silk sutures, leaving the inner lower corner of the wound open for the escape of the secretion. A pad of picked lint was laid on the wound, and kept in position by a flannel bandage. The operation lasted about a quarter of an hour. The child was not anæsthetized.

There was no after-bleeding. Some œdema of the upper lid and moderate suppuration from the wound followed during the next few days. The sutures were removed on the fourth day. The outer third of the wound only remained united. The child had a hot head during the first six nights, and thin greenish evacuations of the bowels. On the eighth day after the operation these symptoms disappeared; the lid was only a little swollen, but somewhat hard at the inner portion of the wound. The bandage was left off from the second day after the operation. The eye-lids were kept clean with a sponge and tepid water. The swelling and hardness in the region of the wound gradually disappeared. In three months the shape, position, color, and movements of the lid were exactly like those of the other upper lid, and up to this day, three years and a half after the operation, no trace of a relapse has made its appearance. When I saw the child lately, I had some difficulty in determining on which side the tumor had been. The recovery, therefore, may be considered both complete and permanent.

Structure of the Tumor.—The *anterior portion* of the tumor had the consistence of normal liver, and appeared lobulated and granular at the cut-surface. It showed, under the microscope, a great amount of small round cells, imbedded in a finely granular

matrix, besides many spindle-shaped and stellate cells, connective tissue and elastic fibres, fat in granules and homogeneous globules, and an ample supply of blood-vessels. According to the arrangement and relative quantity of these elementary parts, this portion of the neoplasm has to be styled, *fibro-lipoma vasculare.*

The *posterior* portion, which was somewhat smaller than the anterior, was also softer and redder. It consisted, under the microscope, mainly of larger and smaller tortuous blood-vessels, abundantly anastomosing with one another. Some of them were characterized as arteries by their thick muscular coats, and had a considerable calibre. The blood-vessels were supported by fibrous substance, in which the connective tissue fibres prevailed over the strongly curved elastic fibres. Only a small amount of cells and fat was present, and this portion of the tumor therefore has to be styled an *angioma fibrosum.*

Remarks on the foregoing Case. — The early removal of the neoplasm was certainly indicated. Apart from the clinical observation of its rapid growth, the large amount of formative cells in its anterior, *i. e.*, larger portion, shows that it was in active proliferation. As the tumor occupied already half the upper lid, and in the orbit reached as far as the equator of the eyeball, there is no doubt that it would have penetrated deeper, invaded the areolar tissue behind the eyeball, produced exophthalmus, and extended possibly through the inferior orbital fissure into the spheno-maxillary cavity. Its removal, without or with the eyeball, would then have been difficult, if not impossible; and cases are on record where for vascular tumors of the orbit the common carotid artery was ligated, and the patient died.

To destroy the tumor with the actual cautery, or by galvano-cautery, might have been possible; but it would have been difficult to reach its root in the orbit without injuring the neighboring parts. The extirpation had the advantage that the deep-seated portion of the growth could be pulled forward.

The difficulties in the above-described operation were to extirpate the neoplasm totally without injuring the elevator muscle of the upper lid, the superior oblique, and the lachrymal sac. The subsequent absence of lachrymal trouble, the perfect position and movements of the eyeball, and the normal elevation and

depression of the upper lid, proved that the necessary precaution during the operation had been taken. One of the surgeons present expressed a fear that the cicatricial contraction in the large cavity of the wound, especially if abundant suppuration were to follow, might produce stiffness and ectropium of the upper eyelid. I was not much afraid of such an occurrence, since it commonly results only from carious destruction of portions of the orbital wall, or extensive phlegmonous sloughing of the orbital tissue.

If in vascular tumors of the orbit the lids are not involved, a careful enucleation is not likely to be complicated by copious hemorrhage. *One little device has, in all cases of orbital angioma, rendered me the greatest service: that is, to introduce the end of a hornplate, properly shaped for the individual case, between the eyeball and the tumor, and press it behind the tumor tight against the orbital wall.* This manœuvre has the double advantage of compressing the afferent blood-vessels behind the tumor, and of making the tumor project, and therefore more accessible.

Since these tumors are loosely connected with the surrounding orbital tissue, they can be readily seized with a strong pair of forceps and drawn forward, by which manœuvre the introduction of a hornplate and the total removal of the growth are greatly facilitated.

If several parts of the tumor are bleeding, they may be grasped and compressed by several fixing forceps simultaneously, which will contribute a great deal to arrest the hemorrhage. After the removal of the tumor, a pressure bandage is commonly sufficient to control the hemorrhage; where it does not, ice, perchloride or persulphate of iron, and tampooning should be resorted to.

4. *Orbital vascular tumors implicating important parts of the eyelids: tarsus, free edge, commissure.*—This group offers greater difficulties than any of the preceding; yet the principles that should prevail in the treatment of these cases are contained in the foregoing remarks. According to the first rule, we should always spare the important parts of the lids. In the majority of

cases it will be best first to extirpate the orbital portion of the growth. This may be done by making an incision either through the skin or the conjunctiva, according to the peculiarity of the case. The denuded tumor should then be drawn forward with a strong pair of forceps, the grasp of which may serve to compress bleeding blood-vessels; a hornplate should be introduced behind the tumor and pressed against the orbital wall, and the tumor enucleated with scissors or knife. The commissure, the free margin, and the tarsus should, if possible, not be interfered with. If the nævus has an epitarsal or outer part, it should be removed as described above. It may be advantageous to extirpate, in the first sitting, the orbital tumor only, and, if necessary, attack the remainder later. Whenever the lid part of the growth is supplied with blood mainly from the orbit, it is likely to shrink after this supply has been cut off, and there will be no need for any further interference. As a brilliant example of this condition, I will briefly relate the following case:

In a child the region of the lachrymal sac and the adjacent skin of both eyelids presented the ordinary picture of flat teleangiectasia (nævus), but in immediate continuation with it an erectile tumor, the size of a large filbert, extended into the inner part of the orbit. The tumor and nævus grew slowly and steadily. In opposition with a very experienced surgeon, who, in consultation, proposed to take away all the vascularized parts of the lids and skin, together with the orbital portion of the tumor, I removed, with his kind assistance, only the orbital tumor by making an incision along the caruncle, freeing the temporal side of the growth, inserting a hornplate, pressing it against the inner wall of the orbit, and then dissecting the whole orbital part of the tumor out, but leaving the skin around the inner corner of the lids intact. There was no great hemorrhage. The result of the operation was beautiful. The dilated capillaries in the skin shrank, and the nævus gradually disappeared without leaving a trace. The recovery was permanent. The removal of the orbital part of the angioma and the cicatrix resulting from it evidently had deprived the teleangiectatic part of its vascular supply, and caused its atrophy. Had I taken away the skin around the inner corner of the eye, irreparable damage would have been done to lids and eye.

If the palpebral portion does not shrink, so much of it should be removed as can be done without interfering with the integrity

of the eyelids. I will, however, not omit to remind the reader that parts of the cartilage, and even of the whole thickness of the lids, can eventually be removed without material detriment to the shape and motion of the lids. If the pieces to be removed are large, one-third of the lid or more, some kind of a blepharoplastic operation will have to be resorted to in order to cover the defect.

OTOLOGICAL PART.

A CASE OF DIPLACUSIS BINAURALIS, WITH REMARKS.

By SWAN M. BURNETT, M.D., of Washington, D. C.

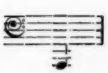
G. K., a German professor of music, aged 59, noticed for the first time, about ten years ago, that an A tuning-fork, when held before the right ear, sounded from $\frac{8}{8}$ *to* $\frac{1}{2}$ *a tone flat.* This he thought to be very strange; but as it caused him no inconvenience in his profession, or otherwise, he paid but little attention to it, always employing the left ear in tuning instruments and when using the tuning-fork.

On being questioned as regards the circumstances under which this phenomenon made its appearance, he remembers at about that time, or previously, he noted a loss of hearing power, subjective noises, and some vertigo.

Since early life, however, he has been troubled more or less with vertigo even more than now, though he had a severe attack last spring. He also has had frequent attacks of "nervous headache," which were relieved by emesis or sleep. These headaches are now less frequent than formerly.

Seven months before calling my attention to his condition (July 29th, 1876), he accidentally noticed that the A fork, when held before the right ear, sounded as b natural, *one tone higher.* This change in the state of affairs arrested his attention, and he has since been observing it more closely, and, in the experiments carried on under my directions, the following facts have been elicited:

The A tuning-fork, as stated, when placed before the right ear is heard as *b natural*, but occasionally varies from that tone by one or two commas ($\frac{1}{8}$ to $\frac{2}{8}$ of a tone). When the fork is placed on the glabella, it is heard as *a*, but when on the mastoid process of the right side as *b* natural, the same as when held in front of the auricle. When the fork is placed on a sounding-board or on a common table, and the ears are applied to it, no difference is observed on the two sides.

On the piano a difference is noted, beginning at the contra A, which sounds in the right ear as *a sharp*, or about five commas higher. This difference lessens about one comma for each octave in ascending, until it disappears altogether.

The violin was used, held close to the ears, and the vibrations were made both by a bow and by plucking the strings, but no difference could be detected.

The same want of success followed experiments with wind instruments.

The timbre of the pseudo-tone of the fork and piano had, if there were any difference, a little less brilliancy than the tone as heard in the other ear.

His general health at present is good, except for a rheumatism of the right-side leg especially—an affection from which he has been a sufferer all his life.

A watch, which is heard at eighteen inches on the left side, is heard at one inch on the right. The membrana tympani is healthy in appearance; he has occasional noises, but there is no discharge from the ear, nor has there been at any time. About the time he first became aware of the diplacusis, however, he noticed that when he struck a note on the piano particularly hard, it gave a sensation of pain in the right ear. The Eustachian tube is pervious.

Accurately observed cases of diplacusis seem to be rare. Prof. *Knapp*, in these Archives, Vol. I., p. 365, records a case, and makes mention in more or less detail of the other cases that had been described up to that time. These cases comprise two recorded by *Moos*, and one by von *Wittich*.

In this paper *Knapp* gives a rational explanation of the phenomena of the affection in accordance with the present accepted views in regard to the physiology of music, and offers suggestions as to the proper study of cases that may come under notice in future—suggestions of which I have availed myself in the instance under consideration.

In order to obtain a clear understanding of the case just related, it will be best, perhaps, to repeat, briefly, the principles, physiological as well as pathological, that enter into a consideration of the subject.

The membrana spiralis, according to the theory of *Helmholtz*, is to be considered as a stringed instrument possessing a fibre which by its length and tension is tuned to each perceptible tone of the musical scale. The two cochleæ are tuned, in a normal condition, in unison.

In diplacusis binauralis there is supposed to be an inter-

ference in the tuning of one of the cochleæ, such as to destroy the harmony that should exist between the two, in order to insure binaural audition.

This interference may be such as to occasion a false higher, or a false lower tone in the affected ear.

In the case reported by *Knapp* the pseudo-tone was *lower* * than in the healthy ear, which would correspond to a tightening of the fibres. In von *Wittich's* case the pseudo-tone was *higher* with a corresponding relaxation of the affected fibres.

In our case the pseudo-tone was first *lower*, and, in accordance with this theory, associated with a *tightening* of Corti's fibres. Subsequently it was *higher*, with a corresponding *relaxation* of the affected fibres.

In von *Wittich's* case the diplacusis was limited to the middle octaves of the piano; in *Knapp's* to the middle and next higher; in ours it extended over about four octaves, beginning with the contra A.

In *Knapp's* case the difference between the two tones was two whole tones, and disappeared gradually; in von *Wittich's* it was one half-tone, and not variable; in ours it was not only variable from time to time, but changed with the octaves, varied with the character of the tones, and for some kinds of tones was not perceptible at all.

In all the reported cases, except in ours, there was an accompanying catarrh, acute or chronic, of the middle ear.

Any discussion of the pathology of diplacusis must, from the nature of the case, be entirely speculative in its character; and, while agreeing with Knapp, that "it is more important to collect facts in relation to this anomaly than to seek for a theory," we cannot but think that an examination of the facts thus far accumulated will not altogether fail to yield some good fruit.

In the cases hitherto reported there has been a high degree of probability that there was a propagation of a morbid process from the middle ear to the labyrinth, since in all there was present an

* There is an error in *Knapp's* report (l.c., p. 369), where he says that the tuning-fork was heard *higher* on the affected side. Further on he says it was heard *lower*, and from the context we judge this to be the case. In this same connection we would call attention to a singular mistake made by Roosa, in his reference to this case, in his textbook. In alluding to it, he says: "Both ears of this patient were affected with double hearing." (P. 490.)

acute or chronic otitis media. And if we accept the theory offered to us in explanation of the phenomenon, we have to deal with an exudation into the cochlea, or at least with an increase of intra-cochlear pressure. That the former is the morbid condition, would appear the more likely, since the false tuning has in all the cases been confined to a limited number of fibres, and does not affect them all, as must have been the case if there were a general increase in the pressure of the liquor Cotugni. That the latter might occur, however, cannot be denied.

It is a very pertinent question whether the symptoms accompanying diplacusis are such as we are accustomed to look for in cases where there is an increase of pressure on the terminal fibres of the auditory nerve.

In none of the cases have subjective noises, vertigo, etc., been at all prominent symptoms. In none of the cases hitherto recorded are these symptoms mentioned, and in ours they were by no means prominent, and the fact of their existence was elicited only by questioning. One feature in our case, which points to pressure in the labyrinth, is the *hyperæsthesia*, which was present early in the history of the affection, if we can accept as evidence of this the pain caused by loud sounds.

As to the character of the exudation causing pressure in these cases, it must either be inflammatory or sanguineous. In our case, if there were inflammatory action going on in the labyrinth, it must have been idiopathic—a fact denied by some writers; but, on the other hand, it lacked many of those intense features which have been asserted by those who contend for a primary inflammatory condition of the labyrinth to belong to the affection.

But, is it not possible that the changes which produce diplacusis may in some cases not be seated in the labyrinth at all, but in the cerebral centre of audition? We simply throw this out as a suggestion, and will reserve its further consideration for its proper place in a paper on the connection between nervous deafness and certain nervous affections.

There are some features of our case, peculiar to it, which are worthy of attention.

It is remarkable that the pseudo-tone varied with the different octaves and with tones of different timbre, and for some kinds of tones was not perceptible at all. In the experiments, it will be

noted that the nearer the tone approached to a simple tone—the fewer over-tones it had—the more pronounced was the pseudo-tone and the greater the interval between it and the tone as heard in the healthy ear. The difference between the two, when a tuning-fork was used which gives a simple tone, was one tone ; in the piano, in the lower octaves, where the over-tones are few, the difference was less marked, being one half-tone, but still greater than in the higher octaves where the over-tones are more numerous. In the violin, where the over-tones are many, no pseudo-tone could be detected. I have not been able to frame in my mind a satisfactory explanation of this curious fact. The nearest approach to it is this : If you take, for the pseudo-tone, a fundamental with a large number of over-tones, especially the middle and higher octaves, there are likely to be among these a number which, either in themselves or their harmonics, correspond to the fundamental of the tone as heard in the healthy ear. These over-tones will reinforce the tone as heard in the healthy ear, and give, so to speak, a *preponderance* to that tone. Applying here the principles that we have seen in action in strabismus, we can readily suppose that the false tone can be to a greater or less extent *suppressed.* In this manner we can satisfactorily explain why the diplacusis has never caused him any serious inconvenience. The suppression of the pseudo-tone is rendered the easier on account of its being much less intense than the tone as heard in the healthy ear, just as the more feeble of the double images in diplopia is more readily suppressed than the distinct one.

Bearing in mind these facts, we are able to infer that diplacusis may be a much more common affection than the record of cases would lead us to suppose, since it can be so readily overlooked. In our case it would never have been brought to light had the Professor not been accustomed to use the tuning-fork, and the difference in pitch would probably have passed unnoticed had he not been a musician.

A CASE OF RESTRICTED RANGE OF AUDITION.

By SWAN M. BURNETT, Washington, D. C.

Mrs. M. P. S., aged about 47, suffered from her infancy to her twelfth year with earaches, which, however, were never accompanied by a discharge.

The peculiarity in hearing under which she labors dates from her earliest recollection, and has never seemed to change from the time she first began to notice it until now. *This peculiarity consists in the inability to hear certain tones.* The singing of most birds is not heard by her at all; neither is whistling, unless it be in a low key; and she has never heard the chirp of a cricket. Words spoken in a whisper are totally incomprehensible to her. Bells of deep tone are readily enough heard, but small dinner-bells of high pitch are indistinguishable. Conversation, when carried on in an ordinary tone, is understood; but when words are spoken in a high key, as when one is speaking to an audience, she finds considerable difficulty in following the speaker. The ticking of some clocks is heard distinctly. When my watch (an English lever) was pressed strongly against the auricle, she experienced a sensation; but whether it was the auditory nerve or only the nerves of common sensation that were affected by the vibrations, it is difficult to say.

In testing on the piano, I found that she distinguished the notes one from the other very readily, until I came to the second C above the middle C of the instrument. All notes above this, she said, appeared to her alike; she could distinguish no difference between them. They had a low, dull, obscure sound, as if a table were tapped with the tip of the finger. The lower notes of the piano were much more brilliant in *timbre* than the higher.

The MTT., on inspection, were of the natural brilliancy. The light spot in the right was of the normal shape and position; in the left it was interrupted in the middle of its course; the Eustachian tubes were patent, —no evidence, in other words, of any present or past inflammatory trouble in the middle ear.

She has never in her life suffered from vertigo, and has never had any subjective noises.

Other members of her family have suffered from earaches; but she alone has this limitation in the range of audition. In her younger years she

learned music on the piano, but always played mechanically, and could never learn "by ear," though she strove hard to do so.

In addition to her defect in hearing, she has also a marked peculiarity in speech. None of the hissing sounds are pronounced. They are substituted by the smooth sound of *th*, or are glided over without any definite sound by the simple expiratory sound of *ha*. Thus the words Mister, Sampson would be pronounced *Mithter*, *Hampthon*. It was a long time before she could learn to pronounce the word *champagne* correctly, calling it invariably *campagne*.

It is these words, too, where the hissing sounds occur, which she experiences the most difficulty in understanding. Sometimes they must be spelled or even written before she can comprehend them.

In her youth she had her frenum clipped by a surgeon, under the impression that her lisping was caused by tongue-tie. It is scarcely necessary to state that no relief followed the operation.

The perception of the higher musical tones and their pathological significance have already been treated of, *in extenso*, in these Archives, by the able pen of Dr. *Moos* (Vol. III., Part I., p. 113, and Vol. IV., p. 469), and it would be superfluous for us here to enter into a discussion of them. Besides, we are not sure that the case reported has any bearings in that direction. It is more than probable that the defect was congenital. It is true there was a history of earaches, but that history was not such, neither were the present indications such, as to point to a condition of affairs that would be likely to bring about the defect under consideration.

In all of Moos's cases there were subjective noises; in ours there were none, and never had been. The condition of the MTT. in Moos's cases was such as to lead to the diagnosis of "chronic catarrah of the middle ear," while no such evidence existed in our case. Moreover, we think that the fact that the limitation was abrupt and occurred at precisely the same note in each ear would militate against the idea of its being of pathological origin. It would be hardly probable that the modification of labyrinthine pressure from any pathological cause would be so exactly the same on both sides.

It is well known that the capacity for hearing very high notes is various in different individuals of otherwise normal hearing power, and also differs in different animals; and the only interest

that attaches to our case in that particular is, that the limitation is very much in excess of what is common.

The two points to which we would call attention, in connection with the case, are physiological rather than pathological.

It will have been observed in the history of the case that, though all notes above c''' (ut^4) ceased to be musical in their character and could not be distinguished one from the other, they were still, in a certain measure, perceptible.

This would appear to substantiate the theory that the perceptive auditory apparatus has two distinct functions with two separate organs for their performance. The office of one of these organs is to take cognizance of sound as noise, the other of sound as music. The cochlea is now accepted to be the organ for the perception of musical sounds, and in our case it is fair to presume that the fibres of that part of the lamina spiralis which corresponds to the higher notes are either absent or are in some manner hindered in the proper performance of their office; while that organ which presides over the perception of aërial vibrations as noise is to a greater or less extent intact.

The fact, that the lower notes of the piano were more brilliant in *timbre* than the higher, finds its explanation in the fact that the over-tones (which give the tone its brilliancy) of the upper notes lie largely in that portion of the musical scale which is beyond the limit of audition.

It is easy to trace the connection between the defect in hearing and the peculiarity of speech. It is certain that we make the sound of our own voices the guide to our articulation. If we cannot hear what we say, we cannot fashion the delicate and complex apparatus for articulation so as to enunciate the sounds we have in our minds to utter. The lady, whose case we have been considering, having never heard the hissing sounds, is not able to judge whether she articulates them or not, and the consequence is that they are either glided over or substituted by some other sounds which appear to her mind to be their equivalents.

It is not improbable that many cases of "lisping" have their origin in this same condition of the auditory apparatus; and in all such cases it would be well to make an examination of the range of audition.

ON THE USE OF NITRITE OF AMYL IN DISEASES OF THE EAR.

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Translated by C. J. BLAKE, Boston.

IN many diseases of the middle and inner ear the accompanying tinnitus aurium, as is well known, is the symptom which causes the patient the greatest annoyance. Such patients often aver that a total deafness would be preferable to the continuous subjective noise, and there have been cases in which the nervous excitement consequent upon the continuous noise has led to melancholia, insanity, and suicide. Aside from their prognostic value, the entotic noises command no inconsiderable degree of professional attention in the direction of therapeutics.

In many cases, especially those in which closure of the Eustachian tube, acute catarrh, exudation into the tympanic cavity, and decided depression of the membrana tympani are the cause, the subjective noises disappear under appropriate treatment.* In a large number of cases, especially in the hypertrophic form of middle ear disease and in affections of the labyrinth, the treatment is frequently of little or no effect. In such cases every variety of narcotic (Rau, Moos, Tröltsch) and of alterative, and the galvanic as well as the faradic current (Benedikt, Brenner, Schulz), have been recommended. The operation of this latter agent has, however, proved most unreliable, although in some cases brilliant results have followed its use. Under these circumstances no apology is necessary for the introduction of new therapeutic experiments, which may lead to relief from so persistent and annoying a symptom.

I was led to employ the nitrite of amyl† in these experiments,

* Politzer, Ueber Subjective Gehörsempfindungen, Wiener Med. Wochenschr., 1865.

† Nitrite of amyl is a narcotic of peculiar character, a fresh colorless, later yellowish fluid, with an odor resembling that of chloroform, its inhalation in small quantity re-

on account of its well-known sedative action upon the sympathetic system, especially the vaso-motor nerves, and the fact that many forms of tinnitus aurium are caused, not by an increased intra-labyrinthine pressure (Politzer, Weber), but occur as the result of nervous irritation of the auditory nerve, or of hyperæmia or anæmia of the brain or the internal ear—the tinnitus resulting from the administration of quinine, salicylic acid, and other drugs, for example, being explainable only in this manner.

During the past three months I have administered the nitrite of amyl in twenty-seven cases in the clinic, and Dr. Urbantschitsch has favored me with the notes of six other cases, occurring in his private practice, in which the same remedy was employed.

The results are as follows: A greater or less degree of improvement was obtained in nineteen cases. Among these were three in which the tinnitus disappeared entirely from one ear, and in the other ear was somewhat diminished. In four cases a by no means inconsiderable improvement in the hearing was observable.* Three cased passed from observation. In the

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sulting in relaxation of the blood-vessels, diminution of the blood pressure, and later vertigo and unconsciousness. Its action on the blood-vessels is shown in a few seconds by the flushing of the face and pulsation of the carotids. The pulse becomes more full—with small doses quicker, with large doses slower. According to the investigations of Brunton and Wood, the apparent action of the nitrite of amyl is independent of the spinal and auditory nerves, as its characteristic symptoms occur after their division. Its effects are directly upon the muscles of the blood-vessels and apparently also upon the bronchial muscles. From one to ten dròps inhaled from a handkerchief have been of service in some forms of asthma and angina pectoris. It is also recommended in epilepsy, eclampsia, and hemicrania (also in melancholia, Meynert; and sea-sickness, Claphan). In all new cases care should be taken to guard against its intense action. One drop may be given, to begin with, and, when necessary, slowly increased. Unfavorable results have not as yet been observed.

The toxical effect soon passes off, as nitrite of amyl is rapidly decomposed, while freedom from the respective attacks is for a time assured.

This remedy is not officinal. It should not have an acid reaction.—Binz, Grundzüge der Arzneimittellehre, Berlin, 1873.

I drop the nitrite of amyl, not upon a handkerchief, but upon charpie or cotton, as it is likely to burn holes in fine cloth. I could not observe that the odor of the drug resembled that of chloroform, but it appeared to me and to most of my patients to have a strong resemblance to the odor of fruit bonbons.

* After completion of this paper, a fifth case was observed, in which the hearing for the watch improved from 2 to 20 c. m. This lasted one day, and then decreased. At the end of eight days the hearing measured 3 c. m. The tinnitus had not resumed its former intensity.

majority of the cases there was an otitis media hypertrophica ; of the cases not improved, one, and of those improved, two, were labyrinth disease. Of the cases improved, one also was a purulent inflammation accompanied by polypi.

From one to five drops of the remedy was inhaled at a sitting. (The one case, in which the application was made per tubam, was without effect.) The inhalation was continued during the appearance of the usual symptoms, flushing of the face, injection of the blood-vessels of the eye, etc., and suspended on the occurrence of vertigo. In all the cases improved, the tinnitus was increased during the period of inhalation. As the flushing of the face disappeared, the tinnitus diminished, and became less than before the application ; the duration of the improvement after an inhalation was very varied. In some cases the improvement lasted an hour, in others several weeks, but generally from two to ten days. In one case the improvement has persisted up to the time of writing—three months. The result of a second inhalation, provided that it did not follow the first too soon (an interval of about two days), was of longer duration than that of the first inhalation. In three cases, in addition to the diminution of the tinnitus, there was an improvement in hearing.

Several patients affirmed that while the tinnitus was not diminished in intensity, it was made more bearable after the application, and in this respect that their condition was much improved. In several cases, in which the remedy was ineffectual, the tinnitus disappeared with the advent of the flushing of the face, and returned in its former intensity as the flushing disappeared ; these cases occurred in young, anæmic women. In other cases the increase in the tinnitus, occurring during the inhalation, persisted several hours ; in one case two days.

A few cases of special interest may be accorded a mention.

L. G., agent, aged 53 years, for ten years has suffered from a considerable degree of deafness and intense tinnitus, in addition complete anosmia, for which the galvanic current has been used. For several years has been treated by means of Politzer's air douche and the catheter, injections of iodide of potassium, and various narcotics, without result, other than a temporary one. In addition, paracentesis has been performed seven times, with only temporary improvement. Depression and

opacity of the membrana tympani of both ears. Eustachian tube free. Otitis media hypertrophica bilateralis.

Feb. 10. Inhalation of nitrite of amyl, gtt. 2. Increased tinnitus during the inhalation, then diminution for half an hour, after which the tinnitus returned in full force.

Feb. 13. Nitrite of amyl, gtt. 2.

Feb. 15. The improvement following the last inhalation persists.

Feb. 17. Improvement continues, gtt. 2.

Feb. 18. Improvement continues, gtt. 2.

Feb. 19. Tinnitus returned in former degree of intensity. No inhalation.

Feb. 21. gtt. 2.

Feb. 23. Tinnitus decidedly diminished.

Feb. 25. Still less tinnitus, gtt. 2, and so on.

The improvement on each repetition of the inhalation lasted, on the average, three days. During this period the tinnitus was much diminished, without however entirely disappearing; but during the longer intervals between the inhalations (eight to fourteen days) the tinnitus did not return to its former degree of intensity. It was remarkable that when the remedy was administered on two successive days, the tinnitus increased instead of diminishing. The patient stated, furthermóre, that since the use of the nitrite of amyl his sense of smell had returned.

Tests with various substances showed that he could distinguish between those which had, and those which had not an odor, without, however, being able to determine the character of the odor.

J. C., aged 32, sempstress. Decided deafness and intense tinnitus for two years. During the past year has been treated by means of the air douche and injections of iodide of potassium per tubam, without result. Depression and opacity of the membrana tympani; auscultation sounds of the Eustachian tube normal. Otitis media hypertrophica.

Feb. 23. Nitrite of amyl, gtt. 2. During the inhalation an increase, and afterward a diminution of the tinnitus; this improvement has persisted up to the middle of May. During the succeeding weeks following the first inhalation, the remedy was repeated several times, for the purpose of entirely quieting the tinnitus, but without this result.

Since the best result possible in the case seemed to have been attained, further applications were deemed futile.

Dr. Pr., physician, had suffered for three years from chronic catarrh of the middle ear, accompanied by intense tinnitus. Treatment by means of the air douche had effected no improvement.

March 20. Following the inhalation of gtt. 2, of the nitrite of amyl, there was a decided improvement, which lasted one hour.

March 22. gtt. 2.

March 24. The improvement has continued up to this morning, gtt. 2.

March 27. The improvement continues, gtt. 2. The further progress of the case is not known, as the patient returned home, proposing to continue the treatment himself.

J. N., aged 34, sempstress, has suffered for two years from chronic catarrhal inflammation of the middle ear, with considerable deafness and intense tinnitus. The usual remedies have been employed without result. During the inhalation the tinnitus disappears entirely, and the patient, who could before hear only a loud tone spoken directly into the ear, understands a whisper. With the return of the natural color to the face, both the deafness and the tinnitus recur. As further applications gave no lasting results, the remedy was discontinued.

K. F., aged 45, teacher, has suffered for several years from deafness and tinnitus. Membrana tympani depressed and opaque. Eustachian tube free. Otitis media hypertrophica. After two applications, the tinnitus had diminished in the left ear, and disappeared from the right ear. The patient having remarked that the hearing was better for several days after the inhalation, at the third sitting the hearing was tested with the following result:

Before inhalation—

R. Watch, 2 c. m.; voice in a whisper, 3 m.

L. Watch, 2 c. m.; voice in a loud tone, 3 m.

After inhalation—

R. Watch, 4 c. m.; voice in a whisper, 5 m.

L. Watch, 4 c. m.; voice in a loud tone, 5 m.

E. K., official, has suffered for four years from deafness and tinnitus. Membrana tympani slightly opaque. Bone conduction for the tuning-fork wanting. After the inhalation the tinnitus was but slight. Tests of the hearing gave the following results:

Before inhalation—

L. Watch, 2 c. m.; voice, 10 paces.

R. Watch, 2 c. m.; voice, 3 c. m.

After inhalation—

L. Watch, 4 c. m.; voice, 16 paces.

R. The same as before.

J. G., aged 50, official, acquired tinnitus from the artillery fire at the storming of Sebastopol, during the Crimean war, which has continued undiminished for twenty-one years, notwithstanding all attempts at relief.

The hearing power, bone conduction, and appearance of the membrana tympani nearly normal. Commotio nervi acustici. After one inhala-

tion the tinnitus ceased in the right ear and was diminished in the left ear; two days later this improvement persisted; the patient then passed from observation.

Of two cases observed by Dr. Urbantschitsch, in one, an otitis media hypertrophica chronica, after an inhalation of two drops of the nitrite of amyl, the tinnitus diminished, and the perception for the tick of the watch by bone conduction, which was before wanting, returned; two days later the tinnitus had not resumed its former intensity. The perception for the watch had, however, been lost, but recurred after a second inhalation.

The second case was a patient with the same disease of the ear, who, some years previously, had a tolerable degree of hearing; though in the best of hands a considerable degree of deafness developed under treatment, so that when she came to Dr. Urbantschitsch she could hear the voice only close to the ear and the watch only on contact. There existed also an unbearable tinnitus. After one inhalation the tinnitus diminished, the watch was heard at a distance of $1\frac{1}{2}$ c. m., and the hearing for the voice had improved in proportion. On the following day the improvement in hearing for the watch still remained.

The introduction of a commended remedy can be hindered in no way so surely as by representing it as infallible. I desire, therefore, to repeat expressly that the desired effect was not attained in all cases; but I have as yet been unable to determine exactly in what class of cases of tinnitus the administration of the remedy is indicated. I can only say that the acute catarrhal cases, especially those in which the tinnitus is evidently of mechanical origin, are not appropriate subjects; but as it is precisely in these cases that Politzer's air douche is most effectual, a new remedy is superfluous.

I should not venture upon a theoretical explanation of the action of this empirically discovered remedy, but the above-mentioned cases of decided improvement in hearing, especially in labyrinthine disease, apparently indicate that its action bears a certain relation to the functions of the auditory nerve or the vascular branches of the labyrinth.* In no case, with the most

* In my own case I observed, before and after inhalation, an increase of hearing for a moderately loud-ticking watch, from 1.94 to 2.02 m. This increase I consider to be too slight to warrant any conclusion; it might be due to increased attention, on account of the experiment. So long as the flushing of the face persisted, a marked diminution of hearing existed.

careful observation, were any immediate or subsequent disagreeable symptoms detected (the inhalation being suspended immediately upon the appearance of vertigo). The slight headache or increased tinnitus, which sometimes occurred in those cases to which the remedy did not seem appropriate, disappeared in a short time.

As the use of this remedy is neither expensive nor requiring too much time for its administration, I believe that its experimental use is indicated in obstinate cases of so-called nervous tinnitus, in labyrinth and middle ear disease, and also, when its effect upon the hearing is further confirmed, in nervous deafness.

THE HISTOLOGICAL CHANGES OF THE EUSTACHIAN TUBE IN CHRONIC CATARRH.

By Prof. S. MOOS.

Translated by Dr. A. N. Blodgett, Boston.

(With Plate XIII., Fig. 15, and Plate XIV.)

Since the introduction of the various aids to investigation in the study of the finer processes in the so-called "catarrh," our views concerning the multifarious changes to which the mucous membrane and its annexa are subject in this pathological process, have become much clearer and more extended.

We owe to the researches of a Virchow, Buhl, A. Thierfelder, Rindfleisch, and others, an insight, for the most part very clear, into the processes and changes of most of the mucous membranes of the human body: of the digestive canal, of the respiratory mucous membranes, of the genital and urinary organs.

The scantiness of our knowledge of the pathological variations in "catarrh" is a humiliation for otology, for so many cases, and certainly not all wrongly, are classed in this category; and the study of these very changes should awaken a lively interest, from the peculiar configuration of the canal, as well as from the practical importance of the subject.

Besides this, a large part of the middle portion of the mucous tract of the ear, the Eustachian tube, maintains a peculiar relation with cartilage and with voluntary muscular fibre, such as we hardly find repeated in the other mucous membranes of the body, with the exception of the conjunctiva bulbi.

In this respect one would expect to find peculiar changes in catarrh of the Eustachian tube, while the changes in the structure of the mucous membrane of the tube itself would show much resemblance to the changes of nutrition of other mucous surfaces.

The material which was available for study was not abundant: consisting of the two tubæ Eustachii of the same man; but the fact that I had the opportunity to treat this case for ten years, and observe the conditions which presented themselves, and the

abundant fruits of the examinations, prompt me to publish the results which were obtained.

Philip Keller, painter, Heidelberg, 41 years of age, presented himself June 21st, 1863, for treatment of disease of the ear, in the Out-patient Department of the Aural Clinic, which I then held in the Ophthalmic Institute of Prof. Knapp, who was at that time in Heidelberg. He dates the origin of his trouble from his ninth year. He is said to have been scrofulous when a youth, and to have suffered much from swellings of the nose and cervical glands, and had a very abundant secretion of mucus; and since that time he has suffered more or less from deafness, becoming much worse during cloudy weather. His deafness was accompanied by dizziness and tinnitus on both sides.* Otherwise he claims to have been always well.†

Status Præsens.—Patient is rather badly nourished, and presents scars over the cervical glands on both sides of the neck, as well as considerable swelling of the glandulæ concatenatæ.

The physiognomy of the patient is much distorted, on account of destruction of the septum narium and retraction of both alæ nasi. The mucous membrane of the nose and pharynx is of a livid color, and much swollen; the uvula considerably enlarged and œdematous; the muciparous glands of the posterior wall of the pharynx are hypertrophied.

The niches of the mucous membrane in both palatine arches are deeply pigmented. A large quantity of mucus, partially glairy, partially greenish-yellow, was removed by Weber's pharyngeal douche. (This has continued ever since.) An examination with the laryngoscope was often attempted, but never with success. (I will here remark that this condition of the mucous membrane was only treated with a palliative result by Weber's douche and gargles of alum.) Cauterization with nitrate of silver was tried, but was omitted, on account of causing considerable hemorrhage, as the patient was already quite anæmic.

Both external auditory canals are rather short, straight, contain a moderate amount of cerumen, and their upper portions are strongly hyperæmic. The hyperæmia spreads over the membrana tympani to the extent of forming a very marked injection about the handle of the malleus, which, as well as the other changes of membrana tympani, continued until the death of the patient, in 1872.

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* Seven years ago patient suffered from parotitis of the right side, which terminated in an abscess, which healed, after being incised by Dr. Alt, of Ladenburg.

† Patient's father died of dropsy; was hard of hearing during his last years; mother died of apoplexy, and was not deaf, nor are his four brothers and sisters.

Right membrana tympani: With exception of the hyperæmia of the handle of the malleus, the membrane has an increased reflex (polish). It is drawn inwards, in a funnel-shape; the manubrium is excentric, being drawn inwards and upwards.

In addition to this, the membrana tympani presents two retractions, in consequence of adhesion to the wall of the labyrinth—a larger one, near the centre of the membrane; and a smaller one, forwards and downwards. In front of this, near the anterior-lower edge, are seen eight linear reflexes, of nearly the same size, parallel to one another, and following a circular direction. The mucous membrane of the drum presents a well-marked sclerotic appearance at the edge of the membrane.

Left membrana tympani: Vessels of manubrium injected; manubrium itself drawn backwards, and inwards, something in form of a sickle. Membrane is funnel-shaped and adherent to the wall of the labyrinth, and presents four partial retractions: one located near the centre, another behind and below it, both about the size of a pin-head; the third, somewhat smaller, is situated above, immediately behind the protruding short process; the fourth is nearly at the centre of the anterior periphery, and is drawn inwards more than the others. Attempts at inflation by Politzer's method, as well as catheterization, prove both tubes entirely occluded. Perception of words existed on the right side five feet, on the left side three feet; a watch, the normal hearing distance of which is thirty feet, was heard only in contact with the ear, and was somewhat more distinctly perceived on the left than on the right side. The conduction of the watch-tick through the bones of the head existed only very slightly on the left side, and was entirely absent on the right.

The diagnosis was double stenosis of the tubæ Eustachii, in consequence of chronic catarrh, as well as hypertrophy and adhesions of the mucous membrane of the tympanum.

The stenosis was demonstrated in the following manner:

A Politzer's manometer was placed in each external auditory canal, and the canal made otherwise air-tight; a solution of carmine was placed in the tubes of the manometer, and its movement observed during inflation by Valsalva's method, as well as by injection of air, Politzer's method, and by use of the catheter. In none of these attempts was there the least observable movement of the liquid in the tubes; and upon this theory the following treatment was commenced: A silver catheter was introduced on each side, and, after verifying their proper position, they were fastened by a Bonnafont's nose forceps. A

catgut bougie, of one millimetre thickness, was then introduced into the catheter, and pushed forwards as far as possible, and left fifteen minutes in this position. The catgut was then withdrawn, and it was quite easy to determine how far it had penetrated into the çanal. The following is an extract from the records of the case.

July 12.—Watch not heard on either side; words heard—right side five feet, left side four feet. In inflating by Politzer's method, the manometer shows a positive movement on the right side; on the left side it is unchanged. Hearing distance for words—right side six feet, left side four feet.

July 26th.—The bougies extend six millimetres into the tubes. August 2d.—Bougies enter on right side eight millimetres, on left eleven millimetres. August 9th.—On right side thirteen millimetres, on left ten millimetres. Treatment is repeated every three days, until August 30th. Hears watch on both sides in contact, and also from mastoid process; hears spoken words at thirty paces. The same treatment is continued until November 8th. Upon repeating the test with the manometer by Valsalva's and Politzer's methods, the fluid in both tubes fluctuates several millimetres. Ocular inspection of the drum during inflation yielded no observable movement of the membrane. Watch heard on both sides in contact; and on mastoid process, words (loud) heard at thirty paces. No more tinnitus. Patient says: "My head feels easy, and I hear my own voice better." Patient was now obliged to move to another place on account of his occupation, so that I only saw him from four to six times a year. The improvement was not permanent. The disease became rapidly worse; the noises were more and more distressing; the hearing distance diminished to such an extent that, for a few weeks before death, he could understand words only when shouted into his ears. He died in the Heidelberg Medical Clinic, May 14th, 1872, aged forty-nine years. The autopsy, by Prof. Julius Arnold, fourteen hours after death, gave the following results: Dura mater unchanged; pia mater infiltrated with serum, cloudy, and hyperæmic; the lateral ventricles somewhat dilated, and contain clear serum; *ependyma* normal; brain substance tolerably firm, moist, and moderately vascular.

Anatomical diagnosis: Chronic ulcerative pneumonia, chronic bronchitis, intestinal tuberculosis, struma, and tracheostenosis.

Autopsy of the two temporal bones.—Both external auditory canals relatively very short, large, and very straight, and contain a moderate amount of brown secretion, which adheres to the walls of the canal.

Right membrana tympani: Vessels of manubrium injected; the short

process very prominent; the handle of the malleus much drawn inwards, and adherent to the wall of the labyrinth at its lower end.

Membrana tympani funnel-shaped, white, of thick, tendinous character, particularly at the anterior lower part of its mucous surface. Two partial depressions are visible on the drum—one about the size of a pea, central, at the point of adhesion of the membrane to the labyrinth; and a smaller one, situated forwards and downwards near the periphery. The hypertrophied mucous membrane of the tympanic cavity invests the bones closely everywhere; the articulation of the malleus and incus only slightly movable; stapes synostotic.

Left membrana tympani: This is also funnel-shaped, and of the same general character as the other drum, and presents four depressions, corresponding to points where the membrana tympani is adherent to the promontorium: one is nearly central; the second, behind and slightly downwards near the margin; the third, somewhat smaller, upwards, above the prominent short process; the fourth and deepest of all is at the anterior margin nearly in its centre.

Sclerosis of the mucous membrane was also found upon this side; diminished mobility of the articulation, and synostosis of the plate of the stapes. The changes of the tubes and of the neighboring pharyngeal mucous membranes will be described later. I will only remark here that the corpse had considerable glairy mucus in pharynx; also in Rosenmüller's depressions. A considerable quantity of mucus was also discharged from the tubes, in attempting to pass the catheter, without any preceptible instance of air into the cavity of the middle ear.

The macroscopic and microscopic examination of the labyrinth yielded nothing unusual.

In my opinion the above-described conditions explain the symptoms of the case during life. The case is one of catarrh of the naso-pharyngeal cavity, of forty years' duration, with a spreading of the disease to the two Eustachian tubes, and through these to the cavity of the tympanum, in which it caused hypertrophy of the mucous membrane, adhesion of the drum to the promontorium, diminished mobility of the malleus upon the incus, and synostosis of the stapes. In my opinion the patient could not have escaped the result so fatal to hearing, even if he had remained under the treatment of June, 1863, which produced a favorable impression; at which time there was adhesion of the drum-head to the promontory and hypertrophy of the mucous membrane of the drum, but probably no synostosis of the articulations.

Clinical experience teaches that, in the stage described, it is impossible to restrain the progressive character of the disease, even in cases where the tubes are not affected by the pathological process. I placed the tubes in Müller's fluid for a long time, then in absolute alcohol, and then made transverse sections, from below upwards, of which I obtained fifty from each tube; and from these sections the following observations have been made:

Relative Size of the Ostium Pharyngeum Tubæ in its Normal Condition.

The size of the ostium pharyngeum tubæ is variable in its normal condition. It is seldom the same on both sides of the same individual. In the adult the sagittal diameter varies from 4.5 to 6.5 millimetres; the transverse diameter from 4 to 5 millimetres. The depth of the cone is from 5 to 6.5 millimetres. The larger measurements are oftener met than the smaller.*

Relative Size of the Ostium Pharyngeum Tubæ in Catarrh of the Eustachian Tube.

Whoever is accustomed to examine ear patients with the laryngoscope, must have often noticed that, in cases of long-continued catarrhal disease of this canal, the funnel-shaped paryngeal opening becomes notably smaller. This appearance is by no means rare. I have often found it, and am only surprised that no one has pointed out the fact of its almost constant occurrence in diseases of this class. In the present case the pharyngeal openings of the tubes appeared as shallow, round depressions, of 2.5 millimetres in diameter and 1.5 millimetres in depth. The explanation of this pathological condition is found in the other

* L. Mayer, Studies on the Anatomy of the Canalis Eustachii, p. 27, asserts that in one case the sagittal diameter of the pharyngeal portion of the canal was 0.7 centimetre; the other diameters were not determined. The transverse diameter could not be obtained in this specimen, as the mucous surfaces were in apposition. Zaufal (Die normalen Bewegungen der Pharyngealmündung der Eustachischen Röhre: Zweiter Artikel, Archiv für Ohrhlk., X., p. 230) says: The orifice of the tubes (observed from the nose of the living patient) appears either as a linear wall or as an opening of 3.4 millimetres in diameter.

changes of the canal; to which I will refer further on. I think I may here emphasize the fact, that when we find the ostium pharyngeum tubæ remarkably small in the adult, in the absence of other causes, we may feel tolerably sure of the existence of a long-continued catarrhal disease of the mucous membrane of Eustachian tubes.

Condition of the Mucous Membrane on the Floor of the Tube.

As is well known, the mucous membrane of the tube is most developed upon the floor of the tube immediately behind the ostium pharyngeum tubæ, and is arranged in longitudinal folds; the transverse sections of which have the appearance of tufts of various forms. As I have elsewhere * demonstrated and explained by plates, these tufts form a slight prominence, even macroscopically, of varying size, which is never absent, and extends at least 0.5 centimetre upwards into the canal. In the two tubes of Keller this prominence had nearly disappeared.

The folds of mucous membrane formed only a trifling prominence immediately within the ostium pharyngeum; further on no thickening at all was noticeable. There is therefore a notable absence of the folds of the mucous membrane of the tube in this case, which is evident to the naked eye. A comparison between sections from this portion of the tube and those from the same portion of a normal tube presented this variation in even a more striking manner. A comparison of all the sections, with a low power, under the microscope, showed that the lateral prominences of mucous membrane in the upper portion of the tube were also wanting; while the median protuberance existed as in the normal condition. The depressions of the mucous membrane were much shallower than normal; and finally the direction of the fold was not constant nor regular. In the normal condition the folds of mucous membrane are generally directed upwards towards the hook of the cartilage; very rarely they follow a transverse direc-

* Compare: Beiträge zur normalen und pathologischen Anatomie und zur Physiologie der Eustachischen Röhre, Wiesbaden, 1874, p. 29, et seq.; und Abbildungen 1, 2, 3. The thickness of the prominence in this case is 5.7 millimetres, the breadth 2.3 millimetres.

tion, more rarely downwards; but in this case many of the folds of the lateral and median mucous membrane were directed downwards towards the floor of the tube. We recur to these appearances again in an explanation further on.

The Mucous Membrane Opposite the Floor of the Tube below the Curving of the Medial into the Lateral Cartilages.

In my work on the Eustachian Tube, which I have quoted above, I have proved (page 31) and explained (Plates III. and XII.) that Rüdinger is mistaken, when he asserts that the longitudinal folds of the mucous membrane, under the cartilage hook, are totally wanting in man—at least as far as the lower portions of the tube are concerned. Indeed, in the normal condition these are constantly found singly or double. In both tubes of Keller these were totally wanting. It follows, therefore, that one of the results of chronic catarrh of the Eustachian tube is a smoothing out of the folds of the mucous membrane. This favors a more intimate contiguity of the opposite surfaces of the tube than in the normal condition. This condition must be a hindrance to the light unfolding of the canal, as it occurs physiologically, and to the rapid and sufficient dilatation (gaping open) of the tube, the closure of which thus becomes pathological. We shall see, further on, that the partial or complete smoothing of the folds, or the varying direction of their points, is the result of an increased activity of the muscles by whose contraction the canal is opened. These are the abductor tubæ and the sulpingo-pharyngeus muscles.

Changes of the Epithelium and Mucosa.

The normal mucous membrane of the Eustachian is clothed by a layer of cylindrical epithelium, which has several series of ciliæ, and by goblet cells—F. E. Schultze.* The views concerning the presence of goblet cells upon the mucous membrane, and opinions as to whether they are normal or simply transitory in

* Archiv von Max Schultze.

their character, are much divided. Brücke has proved, from profile views of the cylindrical cells of the intestine, that, very soon after their removal from the living organism, portions of the contents of the cylindrical epithelial cells are separated, and in this way goblet-shaped cells are found. Stricker and Kooslakoff have shown further that a similar process is peculiarly well marked in acute catarrhal processes.*

G. N. Th. Eimer† maintains, on the contrary, that the goblet cells of the intestine are independent structures. In regard to the conjunctiva, Reich‡ found, in opposition to the view of Waldeyer, who holds the goblet cells as normal secretory formations, that these cells are met more especially in catarrhal affections of the conjunctiva.

In relation to the human Eustachian tube, I can add the following: The presence of goblet cells in the mucous membrane of the normal human Eustachian tubes cannot be denied; they are found principally in the tufts and the lateral depressions of the mucous membrane. Their number is, however, not to be compared with that observed in a condition of acute catarrh (cellular infiltration of the mucosa, sub-mucosa, and the glands), so that one is justified in accepting the opinions of Stricker, Kooslakoff, and Reich, that, in acute catarrh of the mucous membrane of the tubes, the presence of goblet cells is much more marked.

Chronic catarrh, on the contrary, seems to be unfavorable for the production of goblet cells. I was certainly very much surprised not to find one goblet cell by a most careful examination of my specimens.

This unexpected fact leads one to suspect that the striking abundance of goblet cells in acute catarrh of the tube may be due to swelling of the epithelium of the mucous membrane, as this is favored by the abundant exudation of a serous fluid—a process belonging to every acute catarrh, while the exudation of mucus is the principal feature of chronic catarrh. In chronic

* Stricker's Handbook, I., p. 409.

† Zur Geschichte der Becherzellen, insbesondere derjenigen der Schleimhaut des Darmkanales. Inaugural-Dissertation von G. N. Th. Eimer. Berlin, 1867.

‡ Notiz über die sogen. Becherzellen der Conjunctiva des Menschen. Von Dr. M. Reich. Med. Centralblatt, 1874, No. 47.

catarrh of the Eustachian tube, the mucous membrane presents another marked peculiarity: the mucous membrane, in many specimens, was partially or wholly absent. This condition may have been due in part to the method of preparing the specimens; but that cannot account for all, inasmuch as sections of normal tubes, by the same method, did not present that appearance in any such degree. I am inclined to consider the state of the mucous membrane as due to an increased frailty of the epithelial cells, the result of years of catarrh, so that, in cutting the sections, portions were removed from the thickened mucosa.

The sections showed certain portions of mucosa which retained the normal epithelium, while neighboring parts were completely denuded. In many other places, in which the cylindrical epithelium was partially removed, a layer of shorter, pointed cells, or a thick layer of round cells, with a covering of pointed epithelial cells, often provided with ciliæ, was observed. (See Fig. 15, Plate XIII.)

Changes of the Sub-Mucosa.

In the normal condition of the tube, the sub-mucosa consists of a layer of cellular connective tissue, of varying volume, in different portions of the cartilaginous tube. The amount of connective tissue is in inverse ratio to the abundance of glandular structures. In tubes transformed by catarrh, the relations of the tendinous prolongations of the fascia salpingo-pharyngea must be particularly noted. I have proved in another place (loc. cit., p. 24, et seq.), that normally a portion of the prolongations of each layer of fascia intimately unites with the sub-mucosa upon the floor and sides of the tube. A careful examination proves that, in catarrh of the Eustachian tube, as in catarrhal affections of other mucous surfaces, there is a hyperplasia of the sub-mucous connective tissue, the fibrous layer is thicker and broader than normal. (See Fig. 15, Plate XIII.)

The layer of hypertrophied connective tissue is still further increased, in its deeper layers, by attachments of tendinous expansions of the fascia salpingo-pharyngea hypertrophica and its hyperplastic prolongations to the sub-mucosa.

Numerous larger and smaller blood-vessels ramify in the

meshes of the hypertrophied sub-mucosa. The thickened bands of connective tissue can be traced from the acini of the glands on one side, which they assist in forming, to the perichondrium covering the cartilage on the other. (See Fig. 15, Plate XIII.)

Changes in the Muciparous Glands and their Ducts.

The acinous mucous glands of the tube lie in the sub-mucous tissue, and are found on the floor, the lateral and medial portion of the canal. The assertion of Rüdinger, that the mucous glands are absent the whole length of the tube in the vicinity of the "safety tube," is not without exception; at least I possess preparations from the lower (*i. e.*, pharyngeal) portion of a human Eustachian tube in which acinous mucous glands are visible below the concave portion of the cartilaginous hook.* The glandular layer is generally most strongly developed between the mucous membrane and the medial layer of cartilage, and becomes even more marked in the direction of the pharynx. The mucous glands of the Eustachian tube conform in general character to the structure of (mucous) glands elsewhere.

They open upon the surface of the mucous membrane with three orifices between the mucous tufts (papillæ). The duct is made up of a structureless membrane, lined with an epithelium, which, as to its character, is to be placed between the epithelium of the acini of the glands and that of the surface of the membrane.

The course of the ducts is not always uniform, most infrequently they have a direction perpendicular to the mucous membrane (on the floor of the tube of man and of dogs); in the lateral and medial portions of the (human) tube they have an oblique direction, so that they open upon the mucous membrane at a very sharp angle. Sometimes the duct follows a course parallel to the spaces in the connective tissue, and then reaches the surface by an obtuse angle, through the epithelial layer. The calibre of the duct is seldom uniform in its entire length; sometimes it exhibits only slight variations; sometimes a wide duct becomes

* I have also found the same structures in this region, through the whole length of both tubes of a four-year-old bull-dog. One must, however, not forget that in dogs the cartilaginous hook is wanting.

suddenly narrow, as is always the case where the canal passes through a channel between two neighboring cartilages (man, sheep, and dog), and even where the cartilage is not present in the sub-mucosa. The elementary acini of the glands have mostly a rounded or oval form; their size is, even in a normal state, subject to much variation. They consist of a structureless membrane, upon which can be distinguished a wedge-formed epithelium, the nuclei of which lie nearer the walls of the acini. Again, the duct may become quite wide near the orifice, and be very narrow at its opening. It becomes suddenly and permanently larger when another opens into it just within the orifice. As the epithelium of the acini normally does not completely fill the cavity of the acinus, there remains a central cavity of greatly varying size. Sometimes the cells are so flat and so close to the walls that a considerable space remains in the centre; sometimes they project into the lumen of the acinus to such a degree that its cavity is reduced to a minimum; but I have never failed to find a greater or smaller free space in the acinus. Cells resembling lymph corpuscles are also found among the connective-tissue fibres of the sub-mucosa in man and in animals—sometimes scattered singly, sometimes gathered in large groups around an acinus.

The relations of diseased glands and their ducts are in general these: The interstitial (interacinous) connective tissue is much hypertrophied. The walls of the acini appear thickened. They often retain their rounded form, and seem only enlarged. The volume of the gland cells also seems increased, so that the lumen of the acinus is often completely obliterated. This condition might be considered due to a functional hypertrophy—*i. e.*, to an increased amount of protoplasm inside the individual gland cells; or as a passive dilatation, due to retention of the secretion, in which the form of the acini remains unchanged.

The anatomical cause of the retention of the secretion is found in the above-described hypertrophy of the sub-mucous connective tissue. The retention of the secretion often causes a notable change in the form of the alveoli: many lose their rounded or oval form, and the resulting phial, flask, biscuit, crescentic or spiral shape, is plainly the result of a passive ectasis. The possibility that these multifarious variations, in form of the glandular form of the acini, may be due to the various directions in which

the glandular elements are met by the razor in making the sections, and thus cause a confusion of forms, seems to be sufficiently disproved by the fact that I have never found such appearances in sections of normal tubes, where one would expect to find at least slight indications of so marked changes. The ectasia of the ducts never reaches the development which it has in the glands. Their calibre does not differ, on the average, from that of normal tubes; here and there, however, the walls are thickened; but the lateral dilatations are met only very rarely. The thickened submucosa would hardly allow a dilatation of the ducts in this part of their course; but in the meshwork of tissue, nearer the surface, this would be more easily possible. Measurements in respect to the calibre of the ducts yielded the following results: In 22 cases of normal ducts the diameter varied from 0.04258 mm. to 0.11145 mm. The average of the 22 measurements was 0.01400 mm. In forty (40) measurements of diseased tubes (Eustachian) the diameter varied from 0.04258 to 0.13374 mm., with an average of 0.0772 mm. I was very much struck by the scarcity of the ducts upon the lateral portions of the mucous membrane of the tube.

I cannot determine whether this is accidental or is connected with the hypertrophy of the sub-mucosa due to the existence of hyperplasia of the prolongations of the fascia salpingo-pharyngea, thus causing atrophy and absorption of the ducts. But it is certain that the hyperplasia of the tendons of the musculus abductor tubæ has a very pernicious influence upon the glandular layer of the lateral portions of the mucous membrane. A certain portion of the gland structures is pressed to one side by the enlarged tendons, and gradually undergoes atrophy and absorption (compare Plate XIV.). In order to reach, if possible, a satisfactory conclusion upon this point, a number of measurements were made of the breadth of the lateral and medial grandular layers as well as of the elementary glandular cavities of both normal and pathological tubes.

Result of Measurements.

I. *Diameter of Gland-layer in Normal Condition.*

1. Lateral gland-layer.

The average of six measurements was = 0.260 mm.

2. Medial gland-layer, average of six measurements, gave :

a—Above, in region of cartilage hook = 0.556
b—In the centre = 0.920
c—Below, opposite the base of the medial cartilage = 1.283
} average = 0.919 mm.

II. *Diameter of a Pathological Gland-layer ; same number of measurements.*

1. Lateral gland-layer.

a—Minimum ; average = 0.48 mm.
b—Maximum ; average = 0.92 "
c—Average of both = 0.7 "

2. Medial gland-layer.

a—Above *x* = 0.874
b—Centre *x* = 1.380
c—Below *x* = 1.610
} average = 1.288 mm.*

III. *Measurements of Elementary Gland Cavities in Normal State.*

a—Minimum = 0.01340 mm.
b—Maximum = 0.08375 "
c—Average of 18 mm. = 0.04355 "

IV. *Diameter of Gland Cavities in Disease.*

a—Minimum = 0.04335 mm.
b—Maximum = 0.13500 "
c—Average of 18 mm. = 0.06566 "

If we divide the cubical quantity of the breadth of the pathological gland-layer by that of the normal gland-layer, we obtain the number eighteen for the lateral gland-layer, and twenty-seven for the medial layer. If we now divide the cube of the diameter of the ultimate gland acini of the pathological tube by that of the normal tube, we find the result to be 3.4. From these results we learn that there is not only an enlargement of original glandular acini in pathological conditions of the tube, but also an increase in the number of their elements. It is difficult to decide whether this increased size of the original gland

* The places with *x* are the same as those of the first table.

structure is due to functional hypertrophy, in consequence of increased formative activity or to a passive ectasis of the parts.

All the changes in the mucous membrane, the sub-mucosa, the muciparous glands, etc., of the Eustachian tube, which I have described above, with the single exception of the crowding of the gland structures by the hypertrophied tendons of the musc. abductor tubæ, apply also to the same structures of the neighboring pharyngeal surfaces and of Rosenmüller's fossæ.

Changes in the Fascia Salpingo-pharyngea, the Musc. Abductor Tubæ and its Tendon.

In my work on the Eustachian Tube, above quoted (pp. 71, et seq.), I have tried to show that the tube, which is closed during rest, is dilated partially through the immediate or remote influence of the musc. abductor tubæ, partially by the action of the superior and middle constrictors of the pharynx, by means of the fascia salpingo-pharyngea, which is in simultaneous action with the pharyngeal muscles.*

If this view is correct, we might reasonably expect a hyperplasia of those organs concerned in dilating the tube when there has been disease of their canal for a series of years with continued and increasing obstruction to the dilatation; and, in fact, my surmises, in this respect, have not deceived me. The fascia salpingo-pharyngea proved to be thoroughly hypertrophied. The hyperplasia was characterized by a very dense quality of the connective-tissue bundles, partly by a broad ligamentous expansion of certain tendinous prolongations. This was particularly noticeable in parts where the prolongations were inserted into the cartilaginous island on one side, and the sub-mucosa of the floor of the tube on the other. The hyperplasia of the perichondrium led to an increased development of the intercellular substance of the cartilage, and in some portions of the tube the bands of

* In reference to the above-described condition, I cannot but express my sincere regret that, during my last visit to Vienna, it was not possible for Doctor Zuckerkandl to show me a specimen illustrating the ligamenta salpingo-pharyngea which he has recently described. One might almost suspect that these ligaments acquire such marked proportions, as he has described, only in diseased conditions of the tube—a hint which it would be well to regard in this respect.

connective tissue had penetrated between muscular bundles of the musculus levator, and gave the appearance of insular isolation of these portions. Quite the same appearances which I have described as belonging to the tendinous prolongations of the fascia salpingo-pharyngea, are observable in the tendons of the musc. abductor tubæ. The musculus abductor tubæ itself presents a very striking peculiarity. As is well known, the muscle is connected (normally) by tendinous fibrillæ with the retroverted portion of the cartilaginous hook; while in many sections, parallel to the periphery of the hook, striated muscular bundles were found united to the hook by very short tendinous bands; the same thing was also observed in certain sections having a direction towards the fibro-cartilago basilaris.

This state of things may also be considered the result of long-continued catarrh and of the increased labor demanded of the muscles of the part. In view of the fact that, in the normal condition of the parts, muscular fibre is never found in this situation, we may suppose a new formation of muscular fibre—a true (muscular) hypertrophy to have occurred: provided, always, that we do not chance to meet a very rare individual peculiarity in the exceptional insertion of the muscle—a thing which nobody has as yet noted.

Fr. Arnold and Waldeyer have verbally asserted that they never had met this peculiarity. Waldeyer, who saw my specimens, at once pronounced them to be new-formed muscular fibre.

I will also mention that numerous extravasations of blood (hemorrhages) were observed in the intervals between the tendinous prolongations of the musc. abductor tubæ, which may have been caused by some disturbance in the nutrition of the vessels resulting from catarrh.

Changes in the Cartilage.

I have but little to remark in relation to the changes of the cartilage resulting directly from catarrh. The fibrous basement, which is always strongly marked on the edges of the cartilage, was found in different regions, as may be supposed, still more distinctly visible—*i. e.*, at the lateral hook, in consequence

of the tendinous bands of the musc. abductor tubæ; on the superficial edge of the medial cartilage as a result of its union with certain hyperplastic prolongations of the sub-mucous connective tissue, at the edge of the lateral cartilage-islands in consequence of the hyperplasia of the prolongations of the fascia salpingo-pharyngea, which are here inserted into it. I have attached less importance to the tolerably abundant calcification of the cartilages, on account of the patient being of an age in which this condition might be regarded as a senile degeneration.

Explanation of the Plates.

Plate XIV., Fig. 15. A portion of a section from the middle of the right tube: Hartnack ocular two, objective seven—draw-tube not extended.

Magnified primary gland acini with thickened walls and a dilated duct, in which the epithelium is wanting. The cylindrical epithelium of the mucous membrane is also wanting, and on certain portions of the surface are partly round, partly pointed epithelial cells. On both sides of the dilated duct is the thickened sub-mucosa.

Plate XV. A portion of a section from the same position in the upper third of the tube where the mucous membrane is smooth in the normal state.

l. c. = lateral cartilage.

c. m. = medial cartilage.

m. t. = hyperplastic prolongations of the tendon of the musc. tensor veli palati: Hartnack's ocular two, objective four, with draw-tube not extended.

Glandular tissue is situate between the mucous membrane and the medial and lateral cartilages. The hyperplastic prolongations of the tendinous fibres of the musc. abduct. tubæ, which pass from below and laterally towards the calibre of the canal, insert themselves partially into the sub-mucous layer, partially into the perichondrium of the curved end of the lateral tubal cartilage. The atrophic glandular tissue is pushed aside by the hypertrophied fascicles of the tendon of the musc. abduct. tubæ.

THE PRESENCE OF COLLOID MASSES IN THE MEMBRANOUS LABYRINTH OF CHILDREN.

By Prof. MOOS.

Translated by Dr. A. N. Blodgett, of Boston.

(With Fig. 14, Plate XIII.)

In the year 1873 I presented a short communication upon this subject before the Society of "Naturalists and Physicians" at Wiesbaden (see the "Transactions," page 170), which I will briefly review. Masses of colloid substance were found in the entire membranous labyrinth of eight temporal bones of children, with the exception of one case, in which the two laminæ spirales membranaceæ were not examined. Two of the temporal bones had been immersed in muriatic acid (HCl) for some months. Sulphuric acid with and without iodine produced no change. There were also present, in the membranous labyrinth, strongly marked vascularization, a beautiful development of connective tissue, numerous formative cells, and granular fatty cells.

The subjects of the eight cases were: first, a child, five days old, which died of pneumonia; second, a fœtus of eight and a half months; third, a mature but very anæmic child;—there was prolapse of the umbilical cord during delivery, heart sounds lasted a quarter of an hour, but the child could not be resuscitated;—fourth, a child two months old, whose temporals had been in HCl for several months.

Since the publication of the above-mentioned appearances, I have repeatedly found colloid bodies in the labyrinth of children in the following relations:

a—In both temporals of an eight months' fœtus.

b—The same in a new-born child which lived some hours.

c—The same in a child thirteen days old.

d—The same in a child three weeks old.

I did not find them in the labyrinth of a rickety child six months old, whose labyrinth was otherwise normal, which suffered from

suppurative inflammation of the right tympanum with perforation of the drum-head, during the last days of miliary tuberculosis.

These make up all the temporals I have examined since 1873. I therefore consider the occurrence of colloid masses in the labyrinth of children under two months of age as an almost constant condition, and look upon it as a transitional substance, as I have quoted (l. c.).

They are probably the product of a metamorphosis of cells occurring in the differentiation of the tissues. They are found in all parts of the labyrinth—sometimes in groups, sometimes singly. The latter is the rule; their occurrence in groups is rare. I have only found them in one case so abundant as in the plate.

Explanation of Fig. 14, *Plate XIII.*—Group of colloid masses from a portion of the upper membranous semi-circular canal of a child, five days old, which died of pneumonia. In the vicinity of the colloid bodies, and the blood-vessels extending from the periosteum to the membranous semi-circular canals, are numerous formative cells. $\frac{1}{90}$ diameters.

I am indebted to the kindness of *Thoma* for the drawing.

THE DILATATION OF THE BULBUS VENÆ JUGULARIS AND ITS RELATION TO AUDITORY HALLUCINATIONS.

By Prof. S. MOOS.

Translated by Dr. A. N. Blodgett, of Boston.

Under the above title I described a case of auditory hallucinations in this journal (Vol. IV., page 478–482), which terminated in suicide, and in which I ventured to place the enormous dilatation of the bulbus venæ jugularis cerebralis in a mediate relation to the hallucinations of the patient. Shortly after the publication of this case, Prof. Rüdinger, of Munich (Monatsschrift für Ohrenheilkunde, 1874), on the authority of numerous anatomical examinations, denounced my explanation of the case, without regarding the essential points of the explanation at all. I have kept silence in regard to this controversy, and could do so the more cheerfully as I perceived that my elucidation of the facts of the case in their succession were recognized as correct. Jacobi (Archiv für Ohrenheilkunde, Vol. IX., page 292) says: "The eddying current of the blood, which must of necessity result from the marked pathological condition of the bulbus venæ jugularis, together with the perception of the noise occasioned by the eddy, are considered by Moos the source of the auditory hallucinations which were complained of during life."

The causal relation of these phenomena is beyond doubt. Emboldened by my silence, which was occasioned partially by the fact that this journal publishes only original work, and no criticisms, Prof. Rüdinger could not refrain from introducing the same criticism in his "Contributions to the Anatomy of the Organ of Hearing; of the Venous Channel, and of Supernumerary Fingers," Munich, 1876, page 23, where he has written: "In regard to the width of the fossa jugularis, described by Moos, the above-mentioned measurements taken by me in the fossa jugularis prove that such a size is not uncommon. As we are perfectly well

aware that the fossa jugularis and the corresponding jugular vein are almost always broader and deeper on one side than on the other, and as I have preserved several specimens, in some of which the cavity reaches a depth of more than two centimetres, there is no objection to classifying. I do not hesitate to include the temporal bone described by Moos, as far as its anatomical peculiarities go, among these large jugular cavities, inasmuch as the left temporal, in which there was probably a very small cavity for the bulb of the jugular vein,* is not mentioned at all. If the theory of Moos is correct, we must take it for granted that the majority of mankind suffer, from earliest infancy, from subjective sensations of hearing, from the fact that more than half of the people have almost invariably a deep fossa jugularis on one or the other side—a condition which 'statistics upon aural hallucinations have not, to my knowledge, rendered probable.'" (Where are these statistics?)† "Neither the considerable narrowing of one jugular opening,‡ nor the marked enlargement of the cavity of the temporal bone, are to be looked upon as pathological appearances; both deviations are to be ranked among the normal appearances, and are peculiarities dependent upon the character of the blood-current from the cavity of the skull."

In answer to these criticisms, I must remark that Rüdinger has overlooked or neglected the most important link of my chain of conclusions, starting from the fact that subjective perceptions of sound may be the primary cause of a real insanity through supervention of a changed condition of the brain, in which these perceptions become true auditory illusions, as was first proved by Schwartze, and then by Köppe.

I expressed the view that, in my case, there must have been an eddying motion of the blood, owing to the small size of the sinus laterales, and to the enlargement of the bulbus venæ jugularis cerebralis, and in consequence of this a very intense blood murmur, which, from the immediate neighborhood of the en-

* In my case the bone of the other side showed nothing abnormal.

† I should be greatly obliged to Prof. Rüdinger, if he would mention the works, for my better information, which treat upon "the statistical experiences in auditory hallucinations," other than the work of Köppe, referred to by me, in which thirty-one cases are made the subject of his article.

‡ This remark is directed against Kasloff, who found a more or less marked narrowing of the jugular orifice in seventeen out of twenty-one skulls in cases of mania suicida.

larged cavity to the labyrinth, must have caused a most acute subjective perception of hearing; and that the altered cerebral condition, necessary for the occurrence of auditory hallucinations, might have been occasioned by the atheromatous degeneration of the cerebral arteries, as demonstrated at the autopsy, or by the changes in the membranes of the brain—clouding and thickening, or both. I do not attach any importance to the plug of cerumen which had been found in the meatus auditorius externus.

The dilatation of the bulbus venæ jugularis alone, therefore, does not occasion hallucinations, but it must be accompanied by a changed condition of the cerebral substance. This fact lends an increased pathological importance to the dilatation of the bulbus venæ jugularis, the frequency of which is asserted by Rüdinger; and instead of denying the truth of the fact, Rüdinger would have done much better to have informed himself whether the owners of the skulls, which he examined, had suffered during life from subjective noises and auditory illusions or not; for does not the Munich Anatomical Institute receive its bodies, like the others, from prisons, hospitals, and lunatic-asylums? As every controversy has a limit and an object, I express my views upon this subject, as my final argument, as follows: A small lateral sinus, or narrowing of the jugular foramen, in connection with a wide bulbus venæ jugularis, no matter how often it occurs, must, according to the laws of physics, cause an eddying current in the bulb, and produce a subjective impression of sound, and, with the addition of an abnormal cerebral condition, occasion auditory hallucinations or psychoses. Now, as this is not at all infrequent in post-mortem examinations, it acquires at once an increased pathological interest, and it becomes the task of the profession, both aurists and physicians of insane-asylums, to devote especial attention in this direction to cases of continual ringing in the ears, both during life and after the death of the patient.

OTOLOGICAL REVIEW.

By CLARENCE J. BLAKE, Boston.

I. *Johannes Ranke.*—Wahre Hörstäbe und Hörzellen im Ohre von Weichthieren. Archiv f. microscop. Anat., XII., 3, 1876.

II. *Weber-Liel.*—Experimente betreffend die Frage der Uebertragung der Schallwellen auf's Labyrinth in Fällen von Synostose der Steigbügelvorhof-Verbindung. Monatsschr f. Ohrenheilk., II., 1876.

III. *R. Wharry.*—Otitis interna following possible scarlet fever, extensive necrosis of temporal bone, secondary circumscribed meningitis, abscesses in lungs, emphysema and pericarditis. Med. Times and Gazette, London, Sept., 1876.

IV. *Ladreit de Lacharrière.*—De quelques affections herpétiques de l'oreille qui provoquent le plus souvent la surdité. Annales des Mal. de l'Oreille et du Larynx, pp. 175–188, 1875.

V. *Guerder.*—Angine, catarrh de l'oreille moyenne. Irritation de la chorde du tympan. Ann. des Mal. de l'Oreille et du Larynx, Mai, 1876.

VI. *V. Urbantschitsch.*—Geschmacksanomalien bei Otitis Media Purulenta. Anzeiger d. k. k. Akad. d. Wissensch. Wien, April, 1876.

VII. *Anton Steinhausen.*—Die Theorie des Binauralen Hörens. Wien, Carl Gerold's Sohn, 1877.

VIII. *Rayleigh.*—Determination of the direction of a sound source. Nature, 1876.

IX. *L. Turnbull.*—A new artificial membrana tympani. Phila. Med. and Surg. Reporter, Dec., 1876.

X. *Guiseppe Sapolini.*—Nouvel instrument pour l'extraction des corps étrangers du conduit auditif externe. Annales des Mal. de l'Oreille et du Larynx. Juillet, 1876.

I. In vertebrates the ultimate acoustic fibres in the labyrinth enter cylinder cells as their special terminal structure, which cells terminate at the end projecting into the labyrinthine fluid, either

in a single long rod or in a circle of rods, which give the cells a certain resemblance to ciliate cells.

Similar forms of acoustic terminal structures have been found among the invertebrates only in the cephalopods.* In the lower moluscs such structures are entirely unknown. Ciliate cells with vibrating cilia, which are found in the inner epithelial coat of the auditory vesicle in molluscs, have been considered with more or less certainty as the terminal acoustic organ in these animals. The theory of Helmholtz demands, however, as the terminal structure of the auditory nerve, tense structures projecting freely into the labyrinthine fluid, and so constituted as to be set in vibration by the waves communicated to the fluid in which they are bathed. The ciliate structures, set in vibration by forces acting upon the cells, appear unfitted to act simultaneously as a passive, sympathetic acoustic apparatus; and this view has given rise to the question as to whether the ciliate cells could really exercise the function ascribed to them. In the various specimens of heteropods found in such abundance in the Bay of Naples, and especially in the species of the transparent pterotrachea, it was possible to observe during life the true acoustic terminal cells, of cylindrical form, which, crowned with a circle of rods, not only answer the demands of the theory of Helmholtz, but also suggest in their structure the acoustic cells of the organ of Corti.† The rounded acoustic vesicle of these animals hangs on the long acoustic nerve, like a cherry on its stem. In the fluid within floats a large rounded otolith. The epithelial lining of the vesicle consists principally of indifferent epithelial cells, among which are ciliate cells, from the centre of which projects a bundle of vibrating ciliate rods with whip-like extremities. These ciliate cells, less frequent at the point of entrance of the nerve, but larger and armed with bristle-like rods, increase in number towards the opposite end of the vesicle, but diminish in size, so that opposite the nerve are found, in thickly set concentric rows, the smallest ciliate cells, with the shortest and most delicate rods.

* Owsianikow and Kowalevsky, Ueber das Centralnervensystem und das Gehörorgan der Cephalopoden. Mém. de l'Acad. Imp. des Sciences. St. Petersburg, Ser. VII., Tome XI., No. 3.

† Ranke, Der Gehörvorgang und das Gehörorgan bei Pterotrachea. Zeitschr. für wissensch. Zoologie, XXV. Bd.

At this point also is observable, on lateral view, a considerable thickening of the wall of the vesicle, including about one-sixth of the inner surface.

The central point of the globular acoustic organ in pterotrachea is represented by a large cylinder cell arising from the vesicular wall by a broad base, and bearing upon its surface a crown of thickly set, stiff, fine rods. The surface has the appearance of a granular cushion, permeated at a right angle by the rods, which may be followed for some distance into the body of the cell. The relation of the acoustic nerve fibres to these rods is especially worthy of note. Before reaching the point of entrance, the fibres of the nerve spread themselves out under the epithelium, and are then directed, in the majority, towards the acoustic organ; they then enter the above-mentioned "central cell," and it is found that each of the rods studding the surface of the cell is connected at its base with one of the fine fibrillæ of the nerve. It is hardly possible to doubt, therefore, that the rods described form a special terminal apparatus of the acoustic nerve, and that the "central cell" is really an acoustic cell.

The central cell is separated by a comparatively broad space from a ring of cylindrical or finger-formed cells, which, crowned as they are with similar rods, may with equal certainty be considered as acoustic cells. This ring is closely surrounded by a circle of thickly set cells, which, from their intimate connection with terminal nerve fibres in large number, may be considered as a ganglionic ring; they are in their turn closely surrounded by numbers of the smallest ciliate cells.

In fresh subjects the stiff rods of the acoustic cells are easily distinguished from the ciliate coverings of the other cells. The acoustic rods are very transparent, uniformly cylindrical, and terminating in a small olivary point.

The cilia are broader at the base, terminate in a fine, vibrating point, and are much more transparent.

On account of the transparency of even the larger specimens of pterotrachea, the functions of the rods can be observed during life, under the microscope, even with a high power—the transparent surface of the body overlying the acoustic organ serving as a thick object-glass. Under the microscope the cilia, which, in a state of rest, lie upon the inner epithelial wall, are seen to erect

themselves on the occurrence of a sudden noise, and to throw the otolith against the acoustic organ. This change in the position of the otolith is effected through the regular diminution in size of the cilia, the smallest serving as a sort of buffer to diminish the force of the direct blow upon the larger and stiffer rods.

The majority of these most interesting observations of Ranke were independently confirmed by Claus,* in a series of similar investigations; the ring of smaller ciliate cells he however describes as true acoustic cells.

The space surrounding the central cell Claus moreover describes as formed by four elastic supplementary cells; while, according to Ranke, this space is covered by a fenestrated elastic membrane, analogous to the lamina reticularis in mammals.

II. In a paper on the function of the membrana tympani secundaria,† and in the papers published in this volume of the Monatsschrift für Ohrenheilkunde, Weber-Liel concludes, as the result of experimental investigation, that in cases of synostosis of the stapedo-vestibular articulation, when the patient can hear a loud voice, the transmission of the sound waves to the labyrinth occurs through the membrane of the fenestra rotunda. This opinion had been previously advanced by Voltolini; Politzer, however, being of the opinion that the sound conduction occurred through the bones of the head. One of the experiments made by Weber-Liel would seem to controvert this latter view. A glass tube being glued to the temporal bone, and sound conveyed through it, no movement of the membrane of the fenestra rotunda was observed; while in all other experiments, under different conditions, excursions of the membrane were seen. In two fresh preparations a synostosis of the stapedo-vestibular articulation was artificially created. The cavity of the tympanum was freely opened, so that both the membrane of the fenestra rotunda and the niche of the fenestra ovalis were plainly visible; the malleo-incudal articulation was then fastened by means of wax and wax poured into the depression around the stapes; the incudo-stapedial articulation was also similarly treated—excursions of the ossicula being thus rendered entirely impossible, so that no movement

* C. Claus, Archiv für Microsc. Anatomie, Bd. 12, H. 1. Ranke, Monatsschrift für Ohrenheilkunde, 1875, 11.

† Centralbl. für d. med. Wissenschaften, No. 2, 1876.

whatever was observable in the ossicular chain or in the membrane of the fenestra ovalis when the tone of an organ pipe or of the voice was conducted into the external auditory canal.

(The labyrinth having been opened and the parts observed under the microscope, forty diameters.) In a preparation similarly treated, the labyrinth was left intact. No excursions of the ossicula were observed; the membrana tympani, however, exhibited relatively extensive excursions, especially in its posterior superior quadrant. The tympanic cavity was then closed above by a thin cover glass, through which the membrane of the fenestra rotunda could be easily seen. The tones of various organ-pipes being sounded in the external auditory canal, no movement of the membrane of the fenestra rotunda could be observed (under the microscope fifteen diameters). Excursions were immediately visible, however, when the voice was substituted for the organ-pipes and words were either spoken or sung into the ear; these excursions averaged one-half micrometer division in length. The question naturally arises, the stapes being immovable, as to where the compensation for the compression of the fluid in the labyrinth occurs. This, according to Weber-Liel, is furnished either by the aqueductus vestibuli or cochleæ, proof of which he proposes furnishing in a future paper. The connection of the labyrinth with extra-labyrinthine cavities, as indicated by Cotunni, has been treated in a previous paper.*

III. The case reported by Mr. Wharrey, house-physician of St. Bartholomew's Hospital, under the care of Dr. Southey, was that of a boy, fourteen years of age, fairly nourished, but pale and decidedly rickety; the bridge of the nose was flattened, but there were no pegged teeth, nor keratitis, nor other symptoms which would suggest hereditary syphilis.

At the time of admission to the hospital, his expression was anxious; he answered questions but slowly and after hesitation; rather myopic; respirations 28; temperature 99°; pulse 120, irregular; walks, but with some exertion; complains of sore throat; and on the post-pharyngeal wall are dirty yellowish follicular granulations; has been deaf for some years. His present illness began with frontal headache and sore throat nine days before; symptoms of rash not well authenticated; no present desquama-

* Monatsschrift f. Ohrenheilkunde, 1876.

tion; chest fairly well formed and presenting no abnormal physical signs; movements of head restricted in the antero-posterior direction; rotation not so much affected; refers pain to back of head and to glands on either side, which are enlarged. On the following day the hearing was less; there was great pain behind the left ear; parts red, boggy, and tender; sleeps little; partial delirium; respirations 36; temperature 101.8°; pulse 120. On the day following an incision was made behind the ear, liberating much pus, with relief from pain, and diminution of temperature to 100°. On the third day following, offensive discharge from wound; pulse 144; evening temperature 102.2°. The day following, pulse 144; temperature 101.6°; respirations 64; throat red and swollen; tongue dry and brown; pain in left side; free discharge from wound. On the next day, dullness on percussion at the apex of right lung, with bronchial breathing; a pleural friction sound at angle of right scapula; pericardial friction sound; dullness at base of right lung with crepitation.

On the second day following, physical signs in lungs as before; left side of neck very full and tender, with a corresponding fullness in the mouth; very offensive breath; pulse 174; temperature 103.6°; respirations 64.

On the following day, pulse 160; respirations 72; temperature 103°.

From this time on the physical symptoms increased in severity, breathing became more labored, sputum purulent, and the patient died quietly, four days later, without convulsions or paralysis. The autopsy, made three days and a half after death, showed the veins over the left temple enlarged, a fullness beneath the left ear, which on incision revealed a large abscess cavity, at the bottom of which was a large portion of the squamous and part of the petrous bone bare and exposed.

The abscess cavity extended widely in different directions, forwards and inwards to the back of the pharynx and downwards beneath the sterno-mastoid.

The intra-cranial vessels, especially the middle meningeal, were much distended. There was no diffused meningitis, but the dura mater over the petrous bone was injected and roughened, and the layer of bone between it and the abscess cavity was very thin.

The mastoid cells were filled with thick, yellowish matter, and in the jugular fossa was a quantity of the same of the consistence of putty. There was circumscribed empyema on the right side of the chest, extending from the third rib to the sixth; this communicated with a superficial abscess on the lung.

In both lungs, at their surfaces, there were several distinct abscesses, not very large, and filled with creamy pus. The pericardium was universally adherent from inflammation, apparently of not very recent date. The heart, liver, spleen, kidneys, and intestines presented no marked departure from the normal structure.

IV. According to Ladreit de Lacharrière, there are two forms of skin disease which affect the ear and which may lead to deafness; these are eczema and pityriasis. The author's description of the former disease corresponds to that found in the ordinary textbooks.

In the treatment of the chronic form the author gives preference to tar in a fluid state, and objects to the use of ointments or powders when the disease has included the auditory canal, on account of the danger of occluding the passage and preventing the flow of pus or other fluid. For internal medication, arsenic and the water of sulphur springs is recommended.

Pityriasis alba has been frequently observed by the author as affecting the ear, presenting the same symptoms as pityriasis capitis; the disease occurred under his observation only in patients from forty to sixty years of age; at this period of life the hairs in the auditory canal are most fully developed. On removing the grayish pityriasis scales, the skin beneath is found swollen and slightly reddened; the meatus is much narrowed, and the patient complains of throbbing, severe tinnitus, and deafness. In all the cases there was also pityriasis capitis. As compared with cases of aspergillus, the author remarks that, while the latter develops from the depth of the canal outwards, the pityriasis progresses in a contrary direction. In many cases the disease was hereditary. The first necessity in treatment is the removal of the hairs, followed by a local application of a one per cent. solution of corrosive sublimate, sulphur water, etc., and the internal administration of arsenic.

V. The case reported by Dr. Guerder was that of a soldier,

twenty-two years of age, who was attacked with coryza, November 12, 1875, followed by angina. Five or six days later he had diminished hearing of the right ear, accompanied by pain and tinnitus aurium; these latter symptoms soon disappeared, but the deafness remained. At the end of January, 1876, he had a fresh attack of coryza, followed by angina, less intense than the previous attack and lasting only three days; there was, however, a recurrence of the pain in the ear, and a herpetic eruption in the region of the right submaxillary gland; this eruption, very confluent, covered a space of four by two and one-half centimetres. The pain in the ear was sharp and lancinating, compared by the patient to the pricking of needles; they extended outwards to the tragus towards the eruption, and were accompanied by salivation. They exhibited several exacerbations during the day, especially towards evening, and the patient could not rest at night. During these exacerbations the salivation was extremely abundant, and the deafness more intense. Pressure had no influence upon them. There was no sign of stomatitis. This affection, left to follow its own course, soon subsided; but the deafness which remained was made the subject of treatment, and was speedily relieved by the use of the air douche. This case is interesting on several accounts: The radiating neuralgic pains are by no means uncommon in cases of catarrhal inflammation of the middle ear.* In this case a neuritis or perineuritis of the chorda tympani, in its course behind the membrana tympani, resulted in the eruption and the neuralgic symptoms.

The abundant salivation, accompanying these attacks of pain, would seem to confirm the observation of Claude Bernard on the functions of the chorda tympani; and it is in part with reference to these observations that the author has diagnosticated affection of the chorda tympani in this case.

In fifty patients, forty-four having unilateral and six bilateral purulent inflammation of the middle ear, the author instituted experiments on anomalies of taste, using sugar, vinegar, salt, and quinine. In forty-six cases there was functional disturbance of the organs of taste, exhibited in thirty-eight cases as diminution, in three cases as exaggeration, and in five cases exaggeration for

* J. Orne Green, Neuralgia accompanying Aural Affections. Trans. Am. Otological Society.

some substances and diminution for others. There was also in twenty-four cases a corresponding change in the sensation of taste. These anomalies were found to exist most frequently on the side corresponding to the affected ear. In two cases the anomalies of taste disappeared with the cessation of the aural disease.

From these circumstances, as well as from experimental investigation, the relation of the aural disease to the anomalies of taste is established. The medium for this relationship is the chorda tympani and the plexus tympanicus—that is, the anastomosis between the glosso-pharyngeus and trigeminus.

Salivation was also observed as a result of irritation of the N. facialis, which sends fibres to the submaxillary gland through the chorda tympani and to the parotid through the N. petros. superficialis minor.

VI. Prof. Steinhauser's monograph, which is, as it were, a complement of the previous work on the theory of binocular vision, deserves the attention and consideration accorded its predecessor.* The theory of hearing, says the author, in his introduction, may be divided into the monaural and binaural, the first being treated of in the majority of textbooks and considering the structure and functions of the ear; the second, as yet undeveloped, considers the function from the double standpoint of the two ears, and the part which binaural hearing has in the production of symptoms observed in hearing generally. The auricle the author considers as most important to accurate hearing.

According to the direction in which the sound-waves reach the ear, we may designate the direct, indirect, and compound monaural hearing. In the first, the sound-waves pass directly to the ear from the sound source; in the second, they are reflected or conveyed by repetition indirectly to the ear; in the third, the sound-waves reach the ear both directly and by reflection. Direct monaural hearing can of course occur but rarely, as the observer is almost always surrounded by substances and surfaces which reflect or break the sound-waves in varying degree. Viewing the human head from above, and drawing two lines parallel to the surfaces of the auricles, we find that these lines meet in an acute angle at the point of the nose, the lines being continued in a forward direction, we have two lines crossing each other at the

* Die Theorie des Binocularen Sehens. Anton Steinhauser. Wien.

point of the nose (n) and forming an angle (BB), the surfaces of the two auricles being designated by f1, and f2. According to the direction of the sound source, the following conditions, as regards binaural hearing, may be reproduced:

1. The sound source being within the angle D n C, the observer hears directly with both ears simultaneously; there is therefore direct binaural hearing, the range of which is included in the angle D n C = 2 B.

2. The sound source being within either of the angles A n D and B n C, the observer hears with one ear directly and with the other indirectly; there is therefore a compound binaural hearing, included in the angles A n D. B n C, equivalent to 360 – 4 B.

3. The sound source being within the angle A n B, the observer hears with both ears indirectly; there is therefore an indirect binaural hearing included in the angle B n C = 2B. The 360 degrees within which the sound source falls may be portioned as follows:

2B degrees to direct binaural hearing, 360—4B degrees to compound binaural hearing, 2B degrees to indirect binaural hearing. The range of direct as also of indirect monaural hearing of course includes 180 degrees. The angle B varies in different individuals naturally, and is also subject to variation from accidental causes.

Every portion of the auricle which conducts by reflection into the ear, the sound wave falling upon it, may be considered, with regard to the direction of the wave, an effective portion of the auricle. The sum of these effective portions for sound waves of certain direction may be considered as forming the effective or functional surface of the auricle. As, therefore, the functional surface of the auricle varies for each direction of the sound wave, the intensity with which the sound is perceived depending upon its size, it follows that, if the intensity of the perception is not changed by rotation of the head (equivalent to variation in position of the sound source), the size of the functional surface of the auricle must be nearly the same for all possible directions of the sound source.

The auricle, therefore, as a curved-reflecting surface, fulfils an

important office, and the special function of its several divisions may yet be fully determined.*

The body of this most interesting monograph is devoted to the more intimate discussion of

1. The theory of direct binaural hearing,
2. The theory of indirect binaural hearing,
3. The theory of compound binaural hearing,

a just review of which would require the reproduction of the diagrams, without which the algebraic formulæ would be valueless, and which is impossible here. The conclusions, however, may be given at length. The 360 degrees included in binaural hearing may be divided into the anterior range of direct, the two lateral ranges of compound, and the posterior range of indirect hearing. With the head immovable, man is accorded favorable conditions, by means of binaural hearing, to determine from sound perception in which of the above-mentioned ranges of hearing the sound source occurs. A certain knowledge of the direction of the sound source, as also a determination of the direction of its movement, if in motion, is possible only so long as the sound source is within the range of direct binaural hearing.

If the sound source is within the range of either the indirect or the compound binaural hearing, a positive knowledge of its direction is attainable only when by turning the head the observer seeks to bring the sound source :

1. Within the range of direct hearing, or better still, in the direction of the best binaural hearing.

2. On the boundary between two ranges of hearing, the direction of this boundary differing in individuals. This measure has the advantage of requiring only a slight movement of the head.

3. In the known direction of the best monaural hearing, this is especially serviceable when the question arises as to whether the sound source is in front of or behind the observer. The angle B, representing the inclination of the surface of the auricle to the direction of audition, has no unimportant bearing upon binaural hearing under certain circumstances.

As this angle varies in different individuals, the results which

* Functions of the Auricle. C. H. Burnett.

follow an augmentation or diminution thereof may be stated briefly as follow:

The greater B, therefore

1. The greater the range of direct binaural hearing;
2. The smaller the range of compound binaural hearing.

Furthermore,

3. The better or finer the hearing in the visual axis;
4. The greater the range of indirect binaural hearing.
5. The more uncertain the determination of direction in the range of direct binaural hearing; finally,
6. The greater will be the possible distinction in the collective intensity of the sound perceived, according to the position of the head.

Finally, it should be noted that apparently unimportant conditions are sufficient to determine the direction of the sound source, so that this power of localization is sometimes falsely ascribed to the hearing power. The more vivid our imagination, the more readily do we see and hear where there is in truth nothing to be either seen or heard.

VII. In connection with the above paper the following review of a lecture by Lord Rayleigh, quoted in "Nature," is of interest. After considering the various questions which have arisen as to the method of determining the direction of the sounding body, and showing the futility of attempting to draw comparison between the function of the eye and ear in this respect, the author proceeds to state his experiments as follows: The first experiments were made with the view of determining with what degree of certainty the direction of a sound source could be determined. The observer was placed with the eyes closed in the centre of an open space, on a still evening, and directed to indicate with the hand the direction of the voices of five or six assistants, who constantly exchanged their positions. It was necessary to have several assistants, as it was found that their footsteps were easily heard. The result showed that the direction of a human voice could be easily determined within a few degrees, from the speaking of even a single word or sounding of a vowel. With other sounds the result was different. When the sound source was directly right or left, it could be determined, but it was difficult to decide whether a slight sound—a low whistle, for instance—was

more in front or behind. An experiment with a single tuning-fork failed, because the accompanying noise of sounding it revealed its direction. Two assistants were therefore armed with similar forks and stationed in opposite positions. Both forks were sounded at the same moment, but one only was placed upon its resonator. When the observer was so placed that one fork was directly in front of him and the other directly behind, it was impossible to decide which fork sounded; making a quarter turn, however, so that one fork was to the right and the other to the left, the direction of the sound source was at once known. The possibility of distinguishing a voice from in front from a voice from behind would appear to depend upon the composite character of the sound in a manner as yet unexplained, and for which the functional ability of the second ear is not requisite. Even when the sound comes in a lateral direction, the question is not easy of explanation, as the difference in the intensity with which a lateral sound is perceived by the two ears is very slight. The experiment can be roughly made by stopping one ear and turning backwards and forwards in a circle before a sounding body.

Moreover, the human head, considered as an obstacle to the sound-waves, is hardly thick enough, compared to the wave length, to cast an appreciable sound shadow. The author explains this point by estimating the intensity of the sound, from a distant source, for different points on the surface of a solid globular body. The result depends upon the relation (a) between the wave length and the circumference of the ball. Calling the point on the surface of the ball nearest the sound source the anterior pole, and the opposite point, where the shadow is most intense, the posterior pole, the results as regards intensity are represented in the following table—considering the relative size of the ball and the wave length—by three suppositions.

	Anterior Pole.	Posterior Pole.	Aequator.
$a = 2$	0.690	0.318	0.356
$a = 1$	0.503	0.285	0.237
$a = \frac{1}{2}$	0.294	0.260	0.232

When, for example, the circumference of the ball is only one-half of the wave length, the intensity at the posterior pole is only one-tenth less than at the anterior pole, while the intensity is least in a lateral direction.

When a is smaller than $\frac{1}{2}$, the difference in intensity at the two poles is still less observable, and sinks to about one per cent. when $a = \frac{1}{4}$.

The value of a depends upon the wave length, which may vary between wide extremes, and it is to be assumed that the readiness with which a lateral tone is distinguished diminishes with the depth of the tone. In this connection experiments were made with tuning-forks of 128 v. s.; but no greater difficulty was observed than with forks of 256 v. s.

VIII. The modifications suggested by Dr. Turnbull, in the form of a new artificial membrana tympani, consist in making the stem of steel and covering it with a thin layer of rubber, by melting; at the end of this stem is a light metal ring, similarly protected, and bearing stretched across it a thin rubber disc. One of the advantages claimed for this instrument is that the metal stem is attached, not to the centre, but to the circumference of the membrane.

IX. Dr. Sapolini has added to the already extensive surgical armament for the extraction of foreign bodies from the external auditory canal, an instrument consisting of a tube containing two rods, each of which terminates at the extremity of the tube in a curved blade, resembling the blade of a midwifery forceps, unfenestrated; one of these blades slips over the other, in which position the instrument is introduced, and the blades passed to include the foreign body; one of the rods is then rotated, carrying the outermost blade to the opposite side, in which position traction may be made.

EDITORIAL NOTICES.

I. The majority of the plates in the "Archives" are executed by European artists, and their designation is adapted to the German edition. This renders it impossible for the English edition to let them appear in their regular successive order. Some of the plates of the German fifth volume had even to be taken over to the American sixth. As correct references concerning the plates will always be made under the title of each paper, the irregular order of the plates can cause no mistake.

II. Want of space compelled us to suppress the Ophthalmological Review in this (double) number. It will appear in the next.

III. On pages 240 and 241, under section 16, we beg to read *iridotomy* instead of *iridectomy*, wherever it occurs. The punctilious proof-reader, on the authority of his "Webster Unabridged," would not admit the introduction of the novel "iridotomy," and steadfastly recorrected the editor's corrections.

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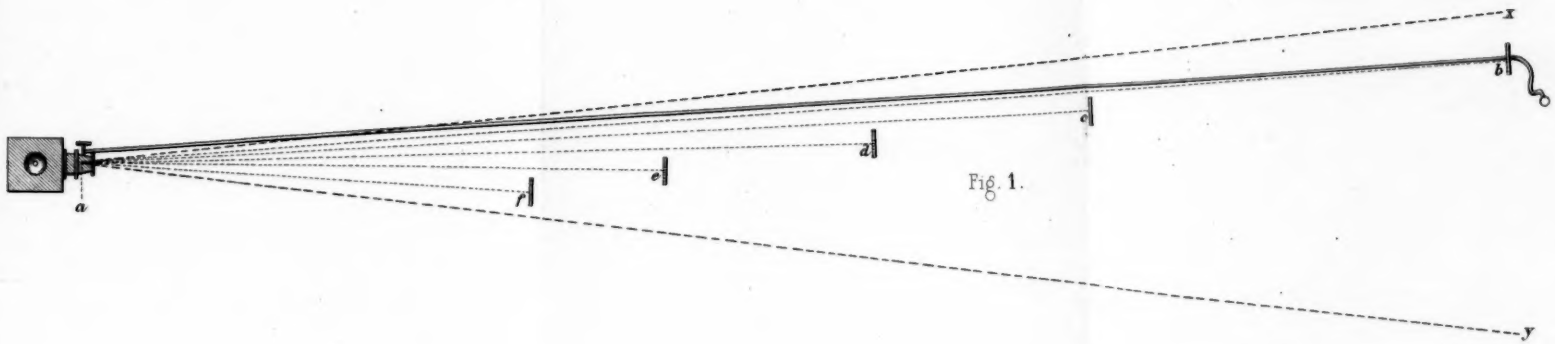

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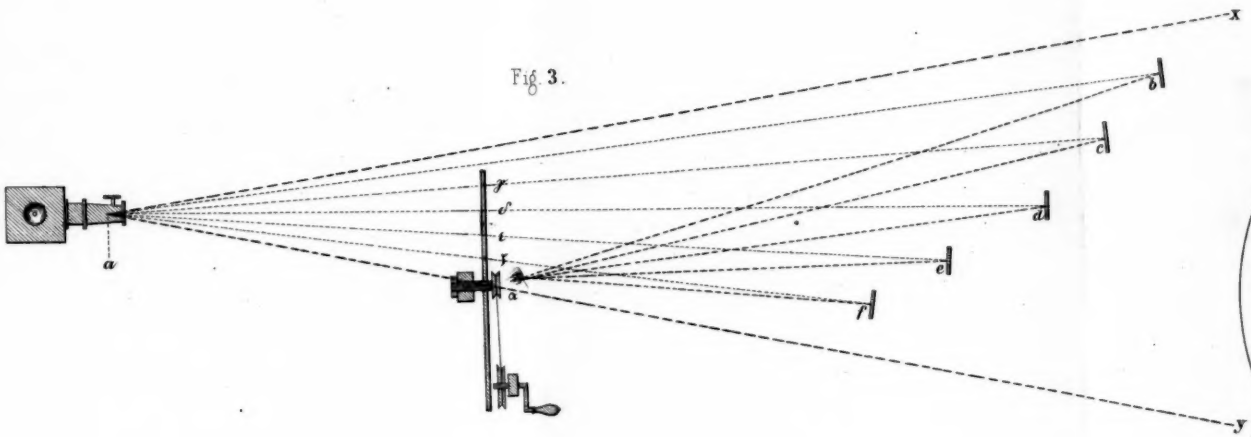

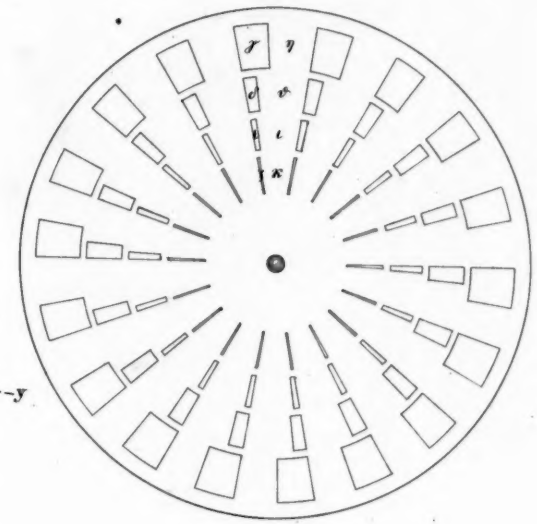

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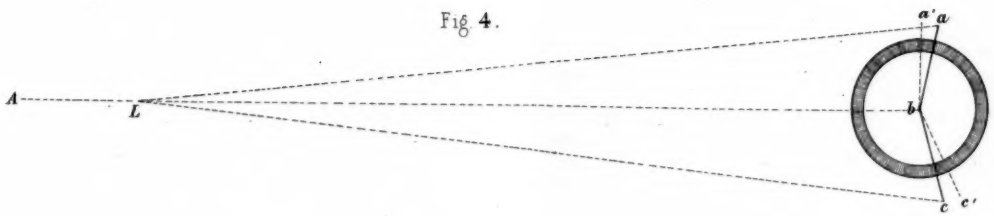

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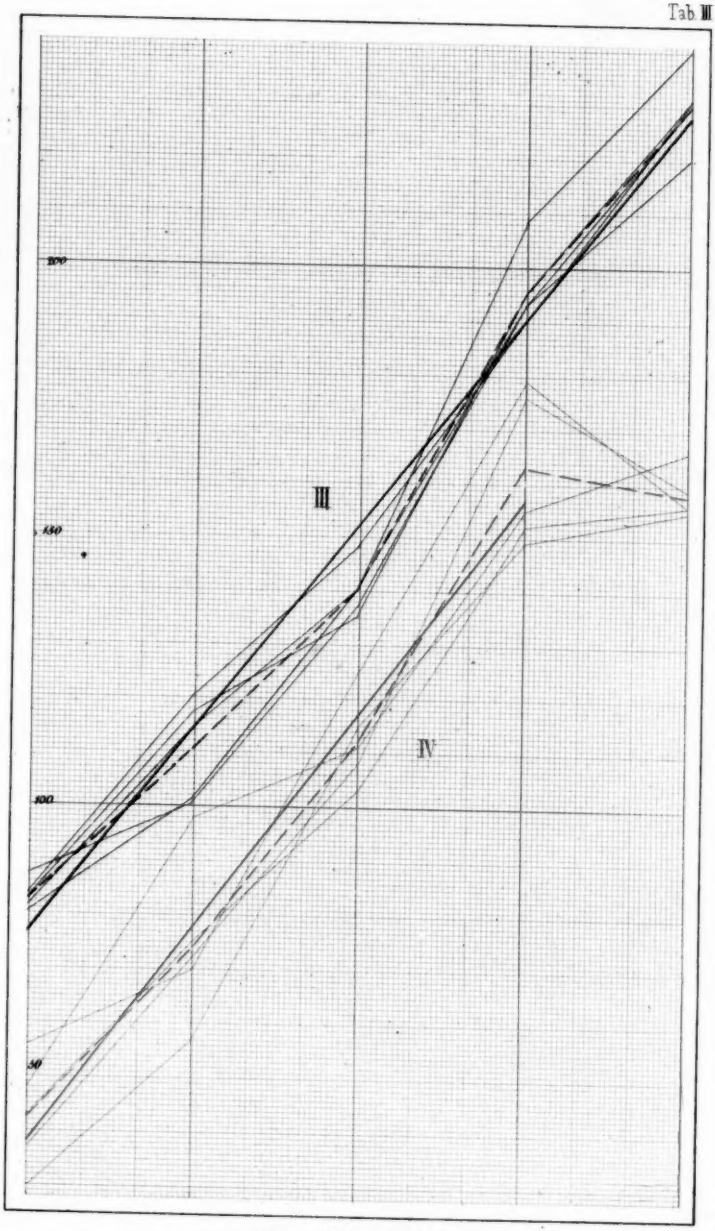
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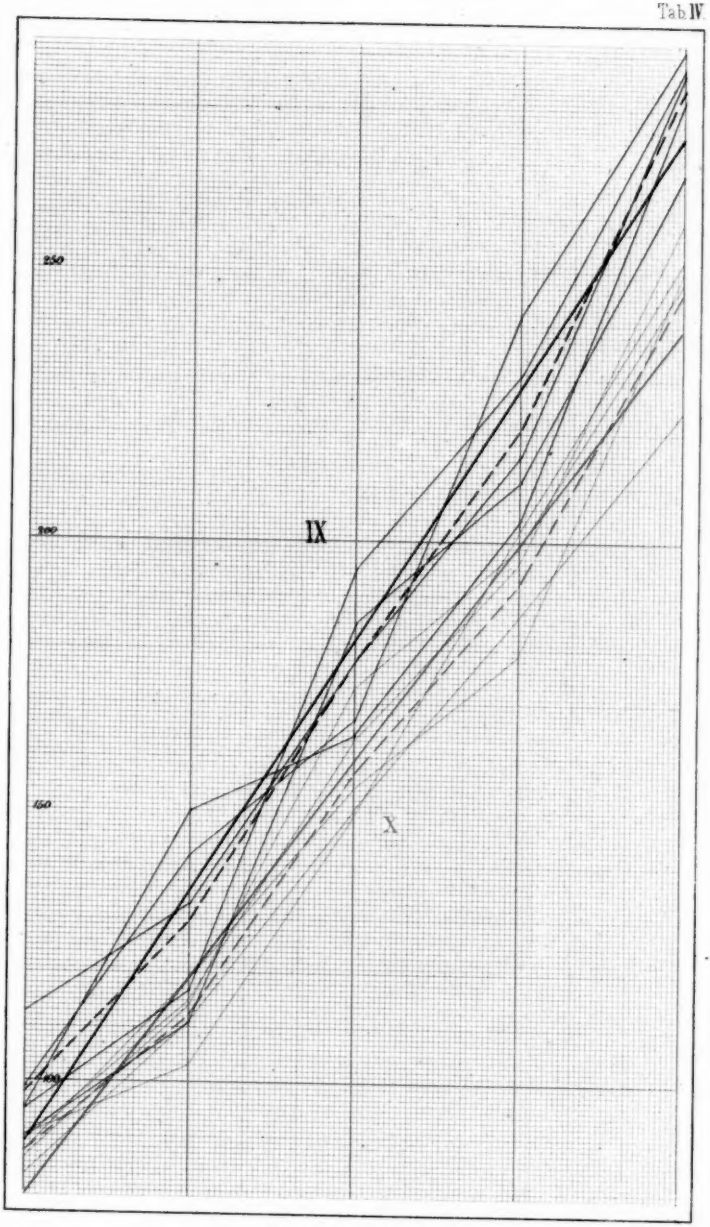
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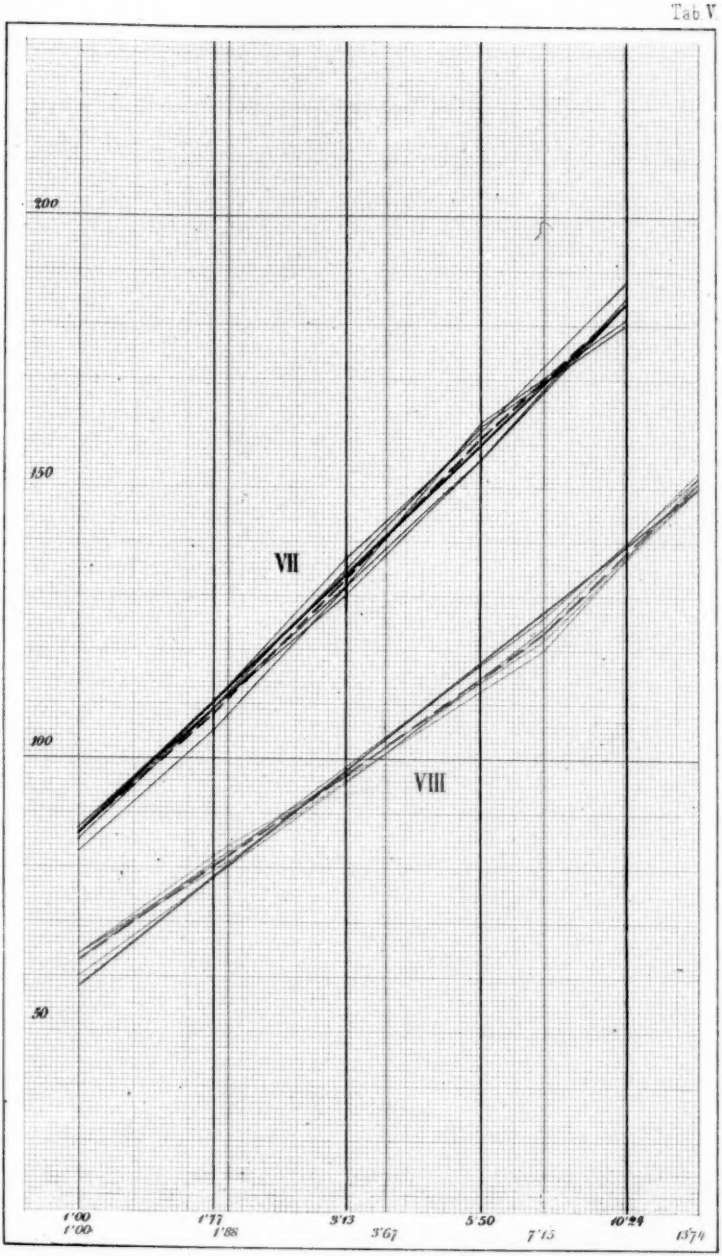
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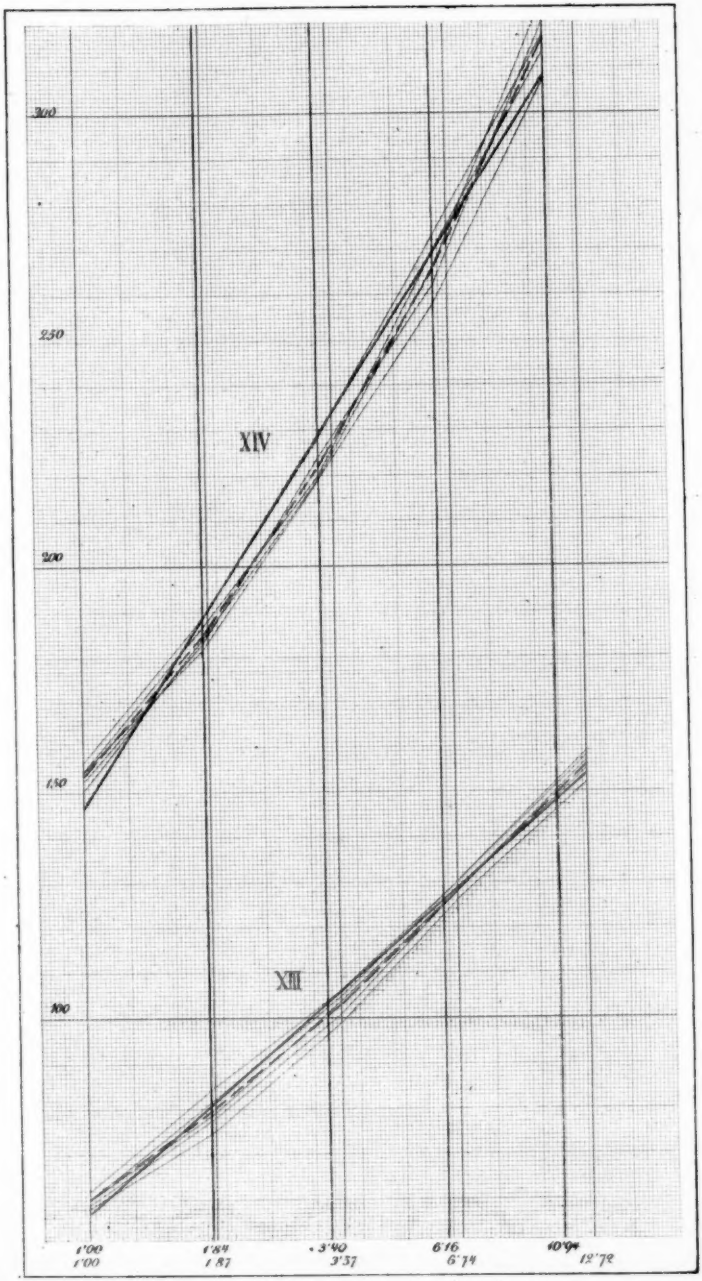
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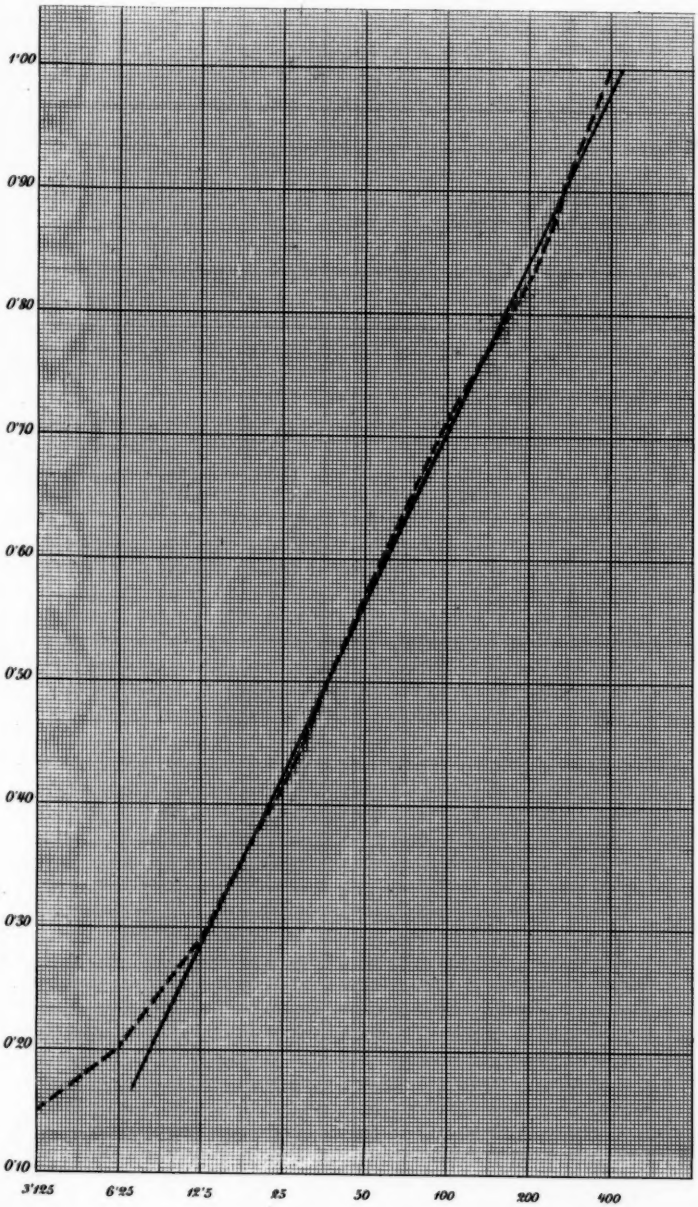
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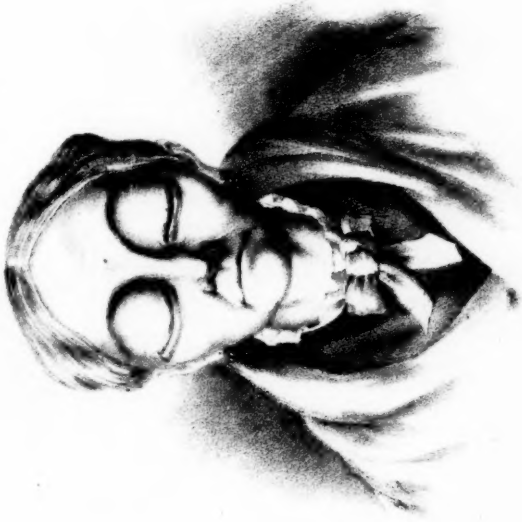

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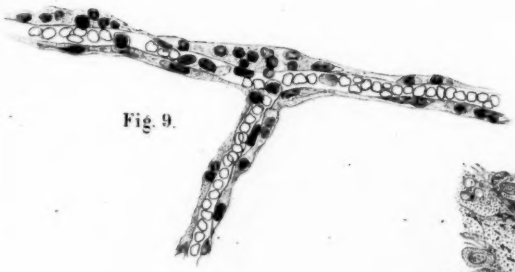

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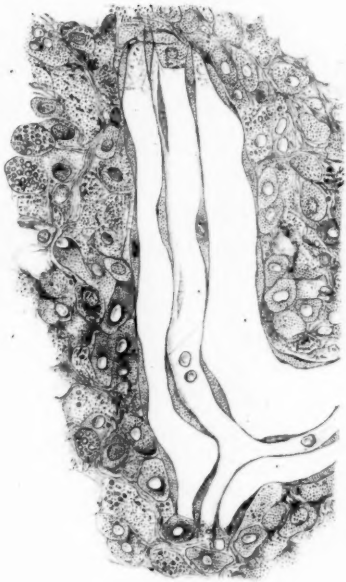

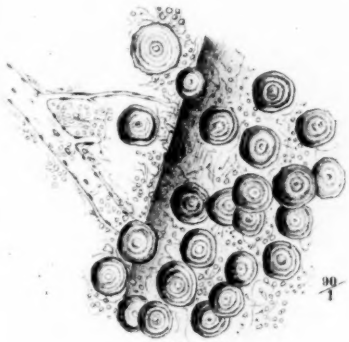

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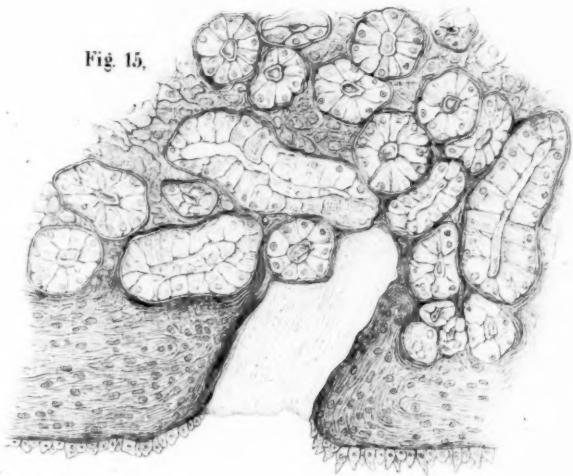

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